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FRUIT JUICES AND FRUIT JUICE BEVERAGES

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UNFERMENTED FRUIT JUICES

During recent years the production of fruit juices has very greatly increased. Several factors have been responsible for this rapid development, the most important being improvements in the quality of the finished products, effective advertising and the enforcement of prohibition.

Because of the increased market for these products there has arisen an insistent demand for information on the methods of manufacture, and the purpose of this publication is to furnish practical directions for the preparation of fruit juices and fruit juice beverages. The contents are based on Circular 220 and Bulletin 359, California Agricultural Experiment Station, both publications being now out of print. This is supplemented by the results of later investigations made by the Fruit Products Laboratory of the University of California.

A pure *fruit juice* may be defined as a natural juice pressed from the fruit and practically unaltered in composition during preparation and preservation.

A *fruit juice beverage* may be defined as a fruit juice considerably altered in composition before consumption. It is usually a juice diluted with water and sweetened with sugar. The beverage may or may not be charged with carbonic acid gas. Examples of fruit juice beverages are orangeade, lemonade and bottled strawberry soda water.

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GENERAL PRINCIPLES

Any fruit juice is best when it is first pressed from the fresh fruit. Treatment that may be given it thereafter usually injures its delicate flavor and aroma, and the most important problem in preparation is that of retaining in the finished product as much as possible of the pleasing qualities of the fresh juice. It is possible to improve its appearance by making it clearer, but not to improve upon the natural flavor.

Preservation.—Fresh fruit juices soon spoil completely through fermentation or molding, if nothing is done to destroy or prevent the growth of yeasts and molds. These are easily killed by temperatures between 160° and 175° Fahrenheit, and if the juice is hermetically sealed, before sterilization by heat, it will not spoil so long as the container remains sealed against the entrance of living yeasts or molds.

Sterilizing fruit juices at temperatures below 212° F is commonly termed pasteurization and is the most generally used process of preservation. Investigations have shown that common pasteurizing temperatures do not destroy all microorganisms present in fruit juices. Spore bearing bacteria often survive but are incapable of growing in the acid fruit juice and hence do not cause spoiling. Yeasts, molds and vinegar bacteria are destroyed by the pasteurizing temperatures recommended in this circular and therefore juices so treated and subsequently protected from reinfection do not spoil. Too high a temperature of pasteurizing or too long a period of heating injures the fresh fruit flavor and imparts a cooked taste.

Juices held in cold storage at 32° F, or above, will in time (six months or less) spoil; but if maintained in the frozen condition at temperatures below 32° F will keep indefinitely. The flavor is only slightly impaired by such treatment, provided the juices are stored in sealed containers to prevent volatilization of aromatic principles and to prevent the absorption of disagreeable odors and flavors. This method of preservation has been tested commercially and appears to have great possibilities.

Chemical preservatives were at one time used freely to preserve fruit juices but are now less popular. Sodium benzoate is the most commonly used of these preservatives and is allowed by law if declared on the label. Sulfurous acid is used to preserve grape juice for special purposes, where it is to be kept a short time, but not for permanent preservation.

If bottles and corks are sterilized and handled without contamination, and if the juice is filtered perfectly clear, thus practically freeing it of molds and yeasts, it is possible to preserve juices in bottles with heavy pressures of carbon dioxide without use of heat or chemical preservatives. Juices so preserved are superior in flavor to pasteurized juices, but the method has not been satisfactory in practice because of the difficulty in avoiding contamination of the juice with molds and yeasts. Spoilage losses are excessive.

Treatment of juices with ultra-violet light has not been very successful as a means of sterilization—although it is said to sterilize water. Recently electrolysis of juices has been advocated for sterilization but this has not proven satisfactory.

Clearing the Juice.—In addition to preserving the juice against fermentation and molding, it is desirable to improve the appearance by making it as clear as possible. Filtration is the most common and also the most satisfactory method. Clearing by centrifugal force and clarification by finings (clarifying materials) are also used. The latter process consists in adding to the juice some substance such as white of egg or casein which coagulates and settles to the bottom of the container, carrying down the particles of pulp and other solids responsible for the cloudiness of the juice.

The use of a small proportion of moldy or soured fruit will spoil the flavor of a large volume of juice. Only sound, clean fruit should be used and all fruit should be carefully sorted. Only clean press cloths, pumps, sterilizers, filters, and containers can be employed if the quality of the product is not to be injured. Cleaning and sterilizing such equipment with hot water and steam is desirable. Press cloths and other equipment should be kept dry when not in use.

EQUIPMENT USED IN FRUIT JUICE PREPARATION

Most of the equipment used in fruit juice manufacture has been developed in other industries, notably in wine making, brewing, and vinegar making. The most common forms of such equipment will be described briefly and illustrated. More complete descriptions may be had from dealers and manufacturers, a list of which is found at the end of this circular. A typical layout of plant for preparing fruit juices is illustrated in figure 29 and an outline of processes is shown in figure 30. An estimated cost of equipment is given in table 1.

Sorting Equipment.—Broad, heavy woven endless cotton or rubber belts which carry the fruit to be sorted slowly past the sorters are often used in canneries and evaporators for sorting purposes and may be used to advantage, especially with apples, in sorting fruit for juice manufacture. Belts made of metal cloth similar to ordinary metal door matting are very satisfactory because they may be easily washed and may be fitted with sprays at one end for washing the sorted fruit. Such equipment is obtainable from any cannery supply company.

TABLE 1

APPROXIMATE COST OF EQUIPMENT FOR PREPARATION OF FRUIT JUICES
(Data, courtesy of The Hydraulic Press Mfg. Co.)

Ten-hour day capacity	200 gals.	250 gals.	500 gals.	750 gals.	1,000 gals.	1,500 gals.
Sorter	$270.00	$270.00	$270.00	$270.00	$270.00	$270.00
Rotary apple washer	360.00	360.00	360.00	360.00	360.00	360.00
Press with elevator and grinder	420.00	420.00	525.00	715.00	715.00	925.00
Filtering, bottling and pasteurizing outfits	1,315.00	1,730.00	2,265.00	2,571.00	2,976.00	3,930.00
Line shaft and belting (press and filtering outfit)	100.00	100.00	100.00	100.00	100.00	100.00
Boiler and stack*	400.00	400.00	400.00	400.00	400.00	500.00
Steam and water piping	105.00	105.00	105.00	105.00	105.00	120.00
Roller conveyor track	41.50	41.50	72.00			
Approximate total price of equipment f.o.b. factory†	3,011.50	3,426.50	4,097.00	4,521.00	4,926.00	6,230.00
Approximate cost of installing machinery	100.00	100.00	100.00	120.00	120.00	150.00
Size, press room	10′ x 12′ x 8′	10′ x 12′ x 8′	12′x 16′x 10′	14′x 20′x 10′	14′x 20′x 10′	16′x 22′x 11′
Room for filtering, bottling, etc	18′ x 24′ x 9′	18′ x 24′ x 9′	20′x 32′x 10′	20′x 36′x 10′	22′x 40′x 10′	24′x 44′x 10′
Size, boiler room	14′ x 18′ x 9′	14′ x 18′ x 9′	14′x 18′x 10′	14′x 18′x 10′	14′x 18′x 10′	14′x 18′x 10′

* Based on 10-horsepower boiler with the exception of that for 1,500-gallons capacity, where 15-horsepower equipment will be needed.

† Does not include cost of building. This can be estimated from dimensions of the rooms.

Washing Equipment.—Fruit often arrives at the factory very dusty or soiled from contact with spoiled fruit. It will generally improve the quality of the product to wash the fruit before crushing. The most effective washing device for fruits that will withstand rough treatment is the rotary tomato washer, shown in figure 1. Berries will not stand rough treatment and must either be rinsed by hand or washed under a gentle spray of water.

Crushers.—The most satisfactory type of crusher for general use is that commonly used for apples under the name of "apple grater." It consists of a cylinder on the surface of which are fixed short knives working against a corrugated plate. In addition there is sometimes a set of concave or upright knives, against which the cylinder revolves.

Fig. 1.—Rotary spray washer for fruits. (Courtesy of Anderson-Barngrover Co.)

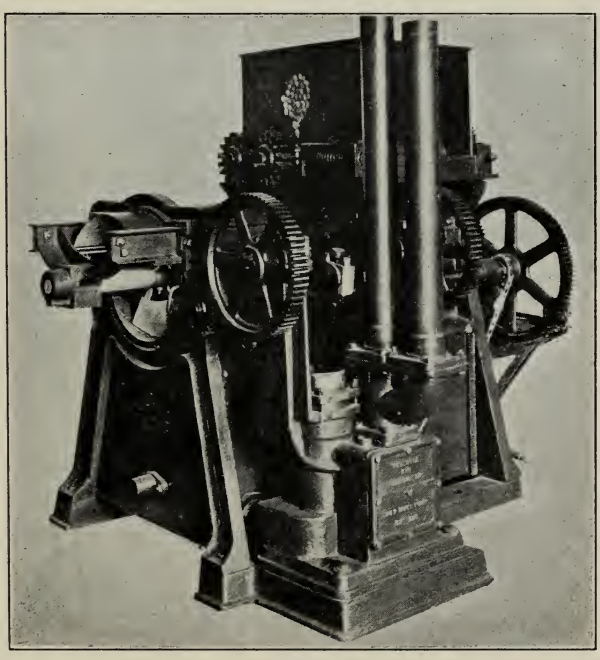


Fig. 2.—Large size grape crusher and stemmer.
(Courtesy, California Press Mfg. Co.)

The fruit is grated or crushed between the plate or concave and the cylinder. The upright knives or the corrugated plate are fixed to strong springs in order that the crusher will have flexibility and not be broken by pieces of wood or stone which may accidentally fall into the crusher.

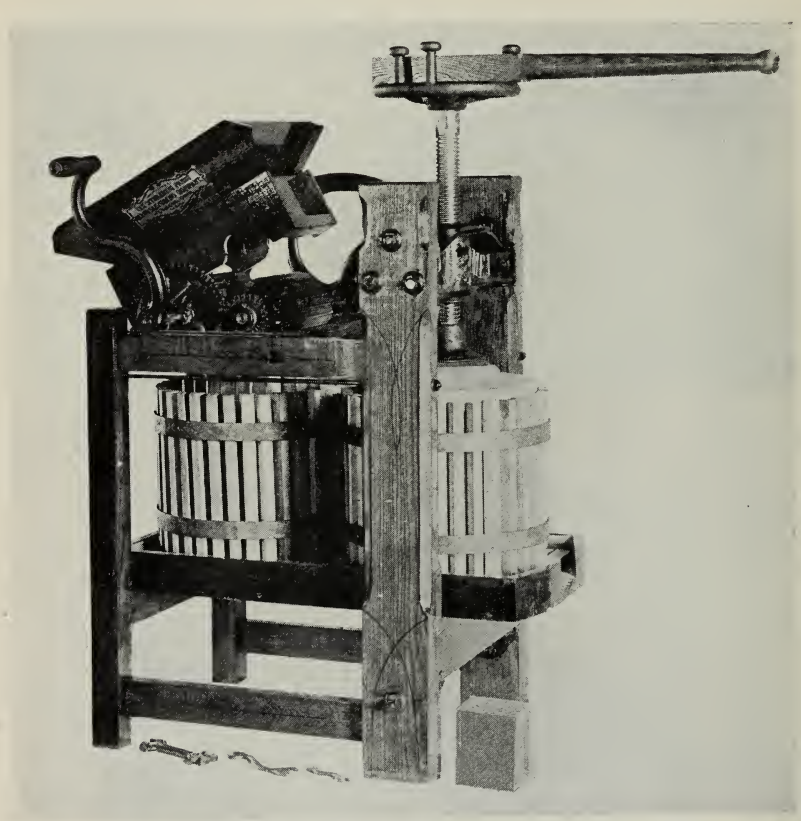


Fig. 3.—Farm size grape crusher and press.
(Courtesy, Hydraulic Press Mfg. Co.)

For grapes, the best crusher consists of two corrugated or fluted metal rollers which revolve close together and toward each other, carrying downward between them, and crushing the grapes that are fed into a hopper above (fig. 2). Connected with the crusher is a stemmer consisting of a horizontal metal cylinder with perforated bottom, through which the grapes are forced by revolving paddles. The stems cannot pass through these openings and are thrown out at the end of the crusher. Grapes for red juice should be stemmed, those for white juice need not be stemmed.

For farm use, small hand-power crushers, usually with a press mounted on the same frame, are available (fig. 3). These are designed either for grapes or for apples, but the apple crusher style will find the greatest application, being suited to both apples and soft fruits. A satisfactory combined crusher and press for home use is shown in figure 4.

Presses.—The press known as the "rack and cloth" press will give a higher yield and a clearer juice than will the basket press. In the rack and cloth press the crushed fruit is built up in layers in

Fig. 4.—Small combination crusher and press suitable for household scale production of fruit juices.

heavy press cloths between racks made of wooden slats. Pressure is ordinarily applied by means of a ram operated by a hydraulic pump, although cog gears are often used. The press is usually attached to the same frame as the crusher (fig. 5).

In basket presses the cloths and racks are not used. The crushed fruit is held in a strongly reinforced wooden basket of cylindrical shape, which rests on the press floor. The basket is movable. Pressure is applied by a lever and screw in small presses and by hydraulic pressure in the larger presses (fig. 6).

A homemade press can be made of farm equipment arranged as shown in figure 7. It can be used either with racks and cloths as illustrated or with a basket.

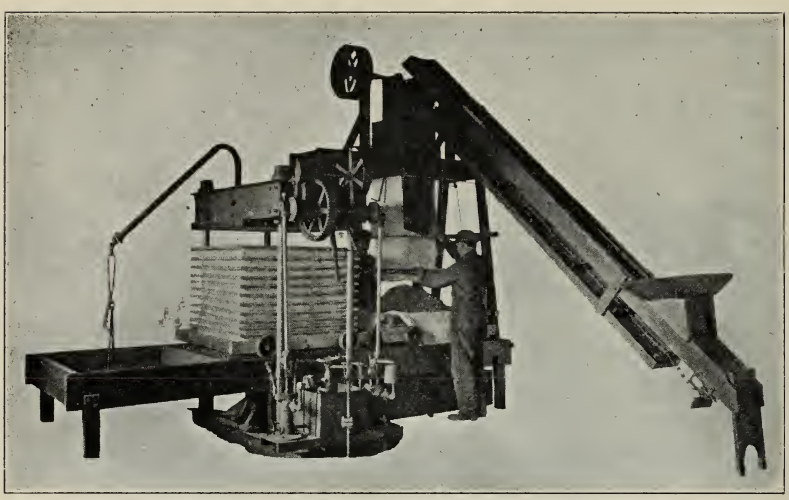


Fig. 5.—Large size apple grater and press.
(Courtesy, Hydraulic Press Mfg. Co.)

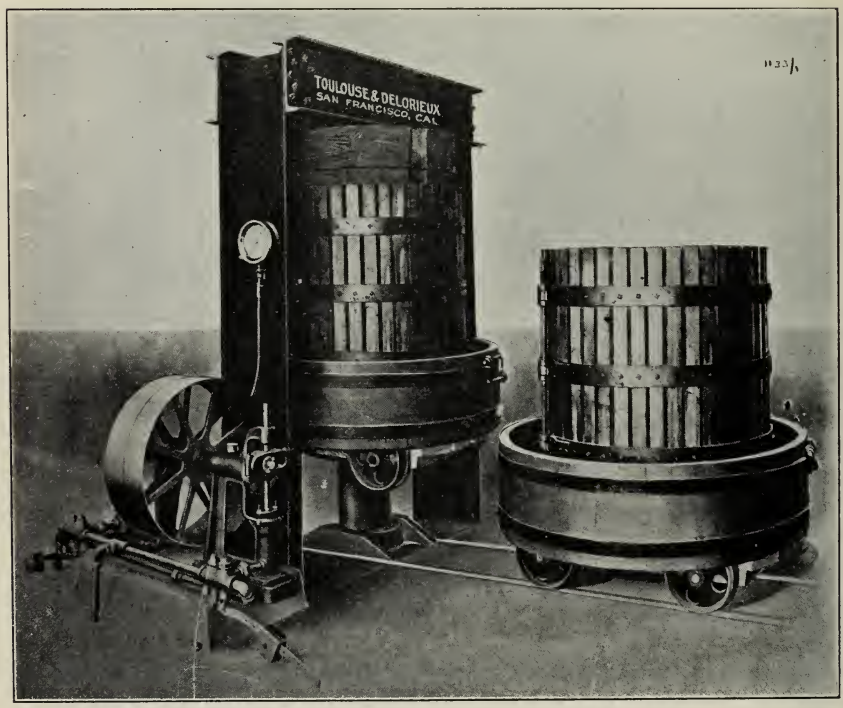


Fig. 6.—Basket type hydraulic press, suitable for grapes.
(Courtesy, California Press Mfg. Co.)

Pasteurizers for Juice in Bulk.—Most juices before filtering should be heated to coagulate proteins and gums which would otherwise precipitate in the bottle and cause cloudiness. Grape juice is usually sterilized and stored several months to permit separation of cream of tartar before bottling. This sterilization is accomplished on a large scale by use of some one of the pasteurizers described in this section.

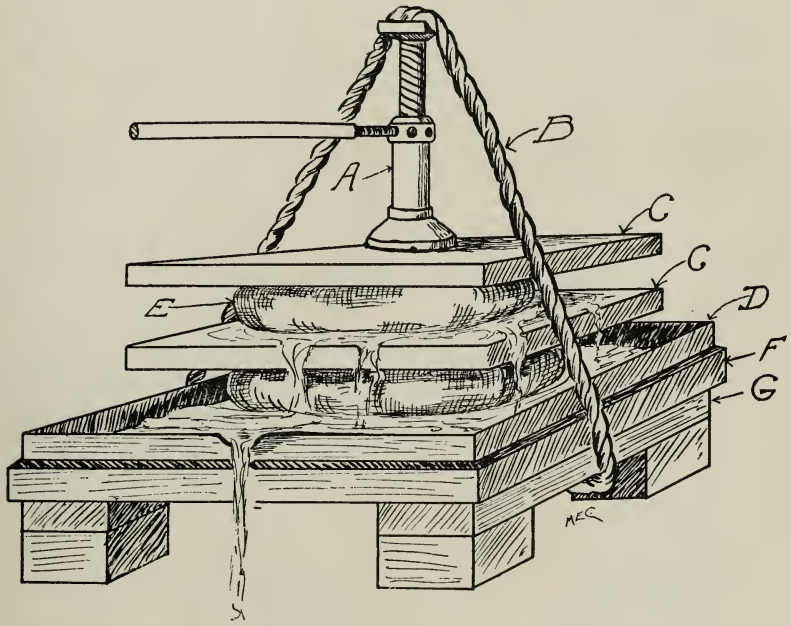


Fig. 7.—Home made fruit juice press. Also suitable for pressing olives for oil. *A*, heavy wagon or automobile jack; *B*, light steel cable or one-inch rope; *C*, two pieces 2″ × 24″ × 24″; *D*, tin-lined sheet metal pan, 30″ × 30″ × 3″ with juice spout as shown; or wooden trough of same dimensions; *E*, heavy burlap to hold fruit; *F*, 3″ or 2″ floor; *G*, frame of 2″ × 6″ pine.

For the purposes of this circular the terms "pasteurization" and "sterilization" are loosely used and sometimes interchangeably, since they are so employed in the industry; furthermore the high temperatures commonly used for complete sterilization are not needed with fruit juices.

A very common and effective sterilizer consists of a block tin or aluminum pipe surrounded by a steam jacket. The juice flows through the inner pipe and steam admitted to the jacket heats the juice to any desired temperature. A thermometer at the juice outlet is necessary for control of temperature. The hot juice may be delivered by means of a hose to the final containers, in place on shelves or racks (fig. 8).

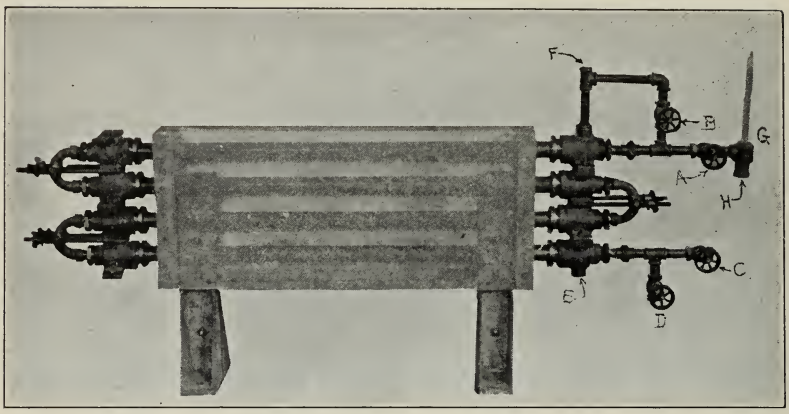


Fig. 8.—Steam heated continuous pasteurizer for fruit juices. *A*, juice valve; *B*, steam valve for occasional flushing out of juice pipe; *C*, juice inlet; *D*, to sewer; *E*, to steam trap; *F*, steam inlet; *G*, thermometer; *H*, juice outlet. (Courtesy, Hydraulic Press Mfg. Co.)

An objection sometimes made to this pasteurizer is that the juice in contact with the walls of the pasteurizer may be overheated and cooked taste be imparted to the juice. This is prevented if the juice pipe is surrounded by hot water instead of steam as indicated in figure 9, where the barrel contains water heated by a steam jet.

Fig. 9.—Continuous water heated aluminum coil used at University Farm for pasteurizing grape juice into barrels or kegs. At left, complete pasteurizer; at right, coil. The juice to be sterilized flows through the coil.

Ordinary large steam jacketed aluminum-walled jelly kettles are very commonly used as pasteurizers in the eastern grape growing districts of the United States. (fig. 10).

The same objection holds with the open kettle as was the case with pasteurizing in the open barrel.

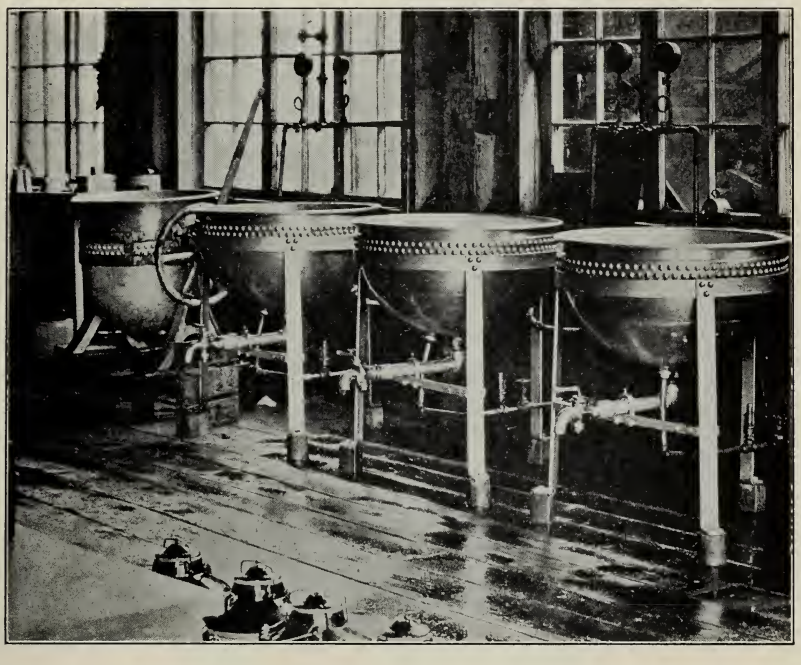


Fig. 10.—Battery of steam jacketed kettles used for fruit juices and jellies. (Courtesy, Wearever Aluminum Company.)

A common form of discontinuous pasteurizer consists of a tank or barrel in which is placed an aluminum steam coil or a tin-coated copper coil. The tank is filled with juice, and steam admitted to the coil heats the juice to the pasteurizing temperature. This pasteurizer is objectionable because of excessive exposure of juice to the air with consequent contamination and oxidation. There is also danger of scorching the juice which is in immediate contact with the coils.

Filters.—Some fruit juices should be made as clear as possible before bottling. This usually involves filtration.

The simplest filter is the bag filter, which consists of a conical heavy duck or felt bag which is used in the same manner as an ordinary jelly bag (fig. 11). The rate and effectiveness of filtration may be increased by the addition of infusorial earth to the juice

before filtration as described later under filter presses. Bag filters commonly hold ten gallons of juice at each filling. They are satisfactory for small scale operations. A small size suction filter for home use has been placed on the market. It is very suitable for small factories, and is known as the "Cellulo filter" (fig. 12).

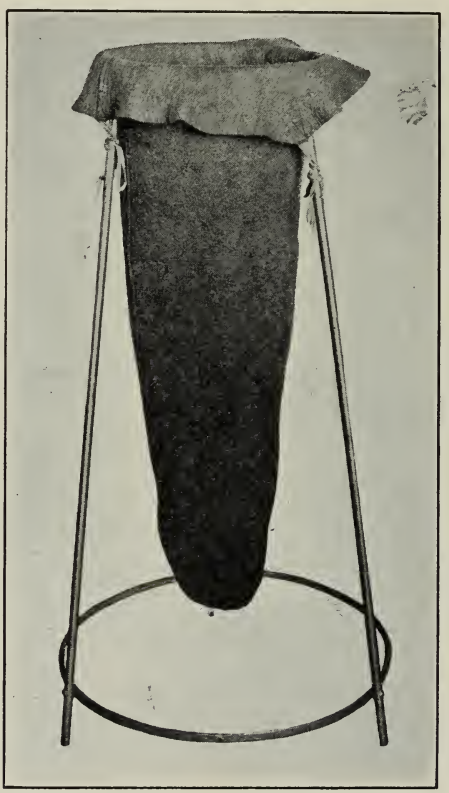
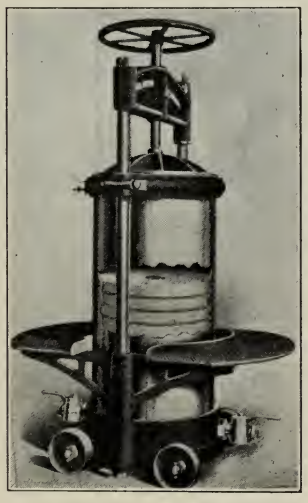


Fig. 11.—Felt jelly bag for preliminary filtration.

For larger scale manufacture of fruit juices some form of pulp filter or asbestos fiber filter is generally used. Pulp filters vary greatly in appearance and design. Figure 13 illustrates a very effective type. It consists of several thick disks of cotton pulp in a tin-lined copper cylinder. The disks of pulp are separated by metal screens and the juice is admitted to the cylinder in such a way that each layer of pulp acts as an independent filter, thus giving a very large aggregate filtering surface. The pulp is washed after use by stirring in water with a mechanical agitator. It is then pressed into disks and used again in the filter. A filter of this type using only two disks has proved satisfactory.

Fig. 12.—"Cellulo" pulp filter, suitable for small scale filtration.



Courtesy
Karl Kiefer Mfg. Co.

Fig. 13.—Wood pulp fruit juice filter.

The Seitz filter consists of a very fine tin or silver screen or series of screens, enclosed in a cylinder or cabinet (fig. 14). The first juice to be passed through the filter is mixed with asbestos fiber of a special grade manufactured for this filter, which gathers on the screen forming a filtering surface. The use of the special fiber in this filter "polishes" the juice, giving it a permanent brilliancy.

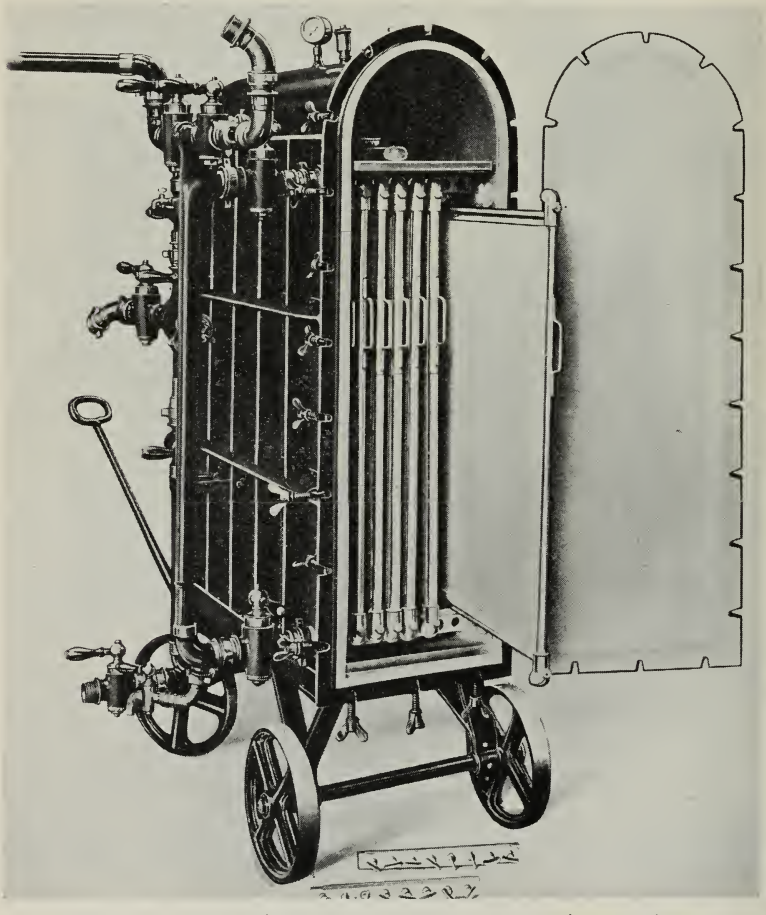


Fig. 14.—Filter using asbestos fiber as a filtering medium. (Courtesy, Donald Robertson, Pacific Coast agent, Seitz filters.)

Filter presses are used in many industries for filtering large volumes of various liquids and have also been used successfully for fruit juices. With these, filtration is accomplished by forcing the liquid under heavy pressure through cloth or canvas sheets held between metal or wooden plates. "Filter-Cel" or other form of

infusorial earth is added to the liquid to be filtered. It should be washed in water before use in filtering fruit juices to avoid the characteristic earthy taste. "Super-Cel" is a specially prepared "Filter-Cel" which does not impart this objectionable taste. Metal parts in contact with the juices should be heavily tinned or silver plated. A small laboratory size filter press shown in figure 15 illustrates the working parts of the factory size filter press very well.

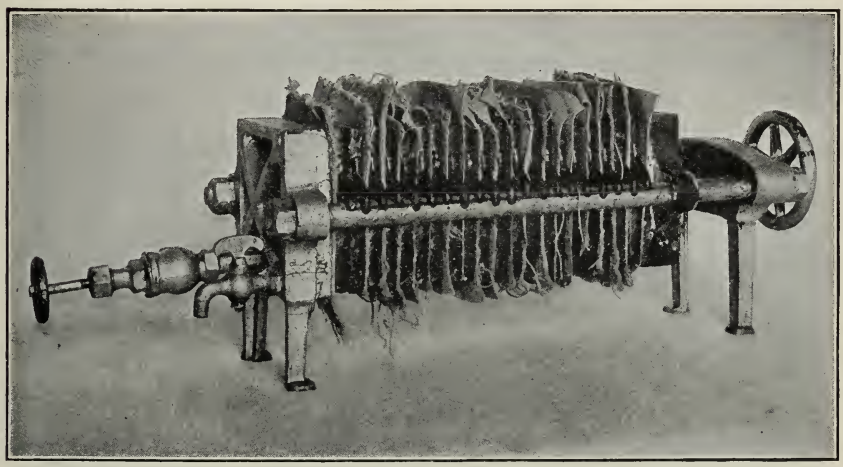


Fig. 15.—Small filter press showing filter cloths and frames in position.

Containers.—Grape juice is usually stored several months at a low temperature to allow the excess of cream of tartar to separate and to aid clarification. Some factories use 50-gallon barrels for storage; glass carboys (demijohns) are better because glass does not injure the flavor of the juice.

Glass bottles are the usual final containers in which the juices are sold. Two types are in use: those closed with an ordinary crown or soda water bottle caps and those upon which the Goldy caps are used. The Goldy caps may be removed without the use of soda bottle opener. Both styles of caps are applied by special machines, which fasten the caps to the bottles by pressure. See figure 16.

Cans may be used for white juices, but the color of red juices often changes to blue or purple in tin or enamel lined tin containers. Enamel lined tin cans also often impart a bitter or resinous taste.

Bottle Pasteurizers.—Large glass carboys used for storage of juices are sterilized by means of live steam in an enclosed box into which the carboys may be run on a truck. They are sterilized in this way just before they are to be filled with hot juice.

Filled bottles or cans of juice are sterilized by heating them in water to the desired temperature. The pasturizer may consist of a shallow metal or wooden vat with perforated false bottom to hold bottles or cans. A perforated steam coil is located beneath the false bottom. The vat is filled with water which is gradually raised to the pasteurizing temperature and held for the required time. A more elaborate pasteurizer of the cabinet type is illustrated in figure 17.

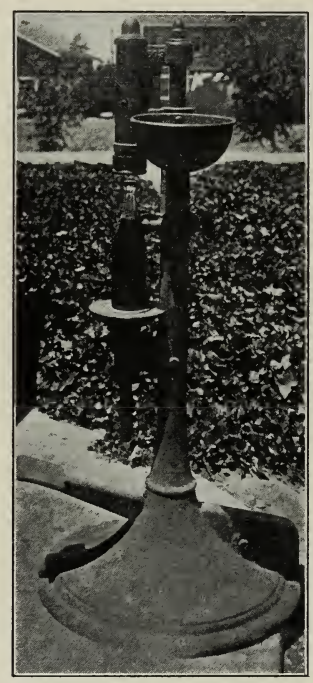


Fig. 16.—Foot-power bottle capping machine suitable for small factories.

The bottles are heated by sprays of water which is gradually brought to the pasteurizing temperature by heating outside the pasteurizer, and delivered to the sprays by a pump. The water is collected and re-circulated through the heater and pump.

Steam Supply.—A steam plant will be necessary except for the very smallest factories. To operate a pasteurizer capable of sterilizing 500 gallons of juice per hour a 25 horsepower boiler should be available; other sizes in proportion to output. Steam is also necessary for sterilizing empty barrels, carboys, pipe lines, press cloths, etc., that come in contact with the juice; but if the boiler is large

enough to operate the pasteurizer, it will also furnish enough steam for these miscellaneous purposes. It is desirable that steam and an abundance of water be available in any plant.

Bottle Filling Machines.—In the production of bottled juices in quantity some form of automatic bottle filler will be needed (fig. 18). Those formerly used in breweries answer the purpose very well. For the small factory a soft half-inch hose and a small hand bottle filling device may be used.

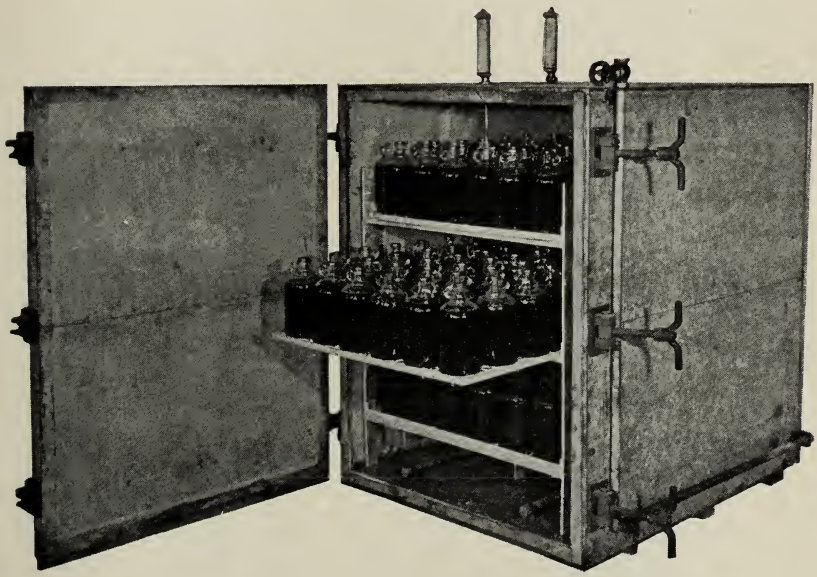


Fig. 17.—Cabinet form of bottled juice pasteurizer.

(Courtesy, Hydraulic Press Mfg. Co.)

Labeling Machines.—Bottles or cans may be labeled by special machines much more rapidly and just as neatly as by hand. Such a machine is almost a necessity for large plants, but is not needed in small plants.

Equipment for Home Manufacture of Juices.—Small combination fruit crushers and presses for use in the kitchen may be bought through any hardware store. Grapes and berries may be crushed with a potato masher, or by the hands, and pressed in a small meat press. An ordinary jelly bag made of muslin or flannel will serve for a filter. A wash boiler fitted with a false bottom may be used as a pasteurizer.

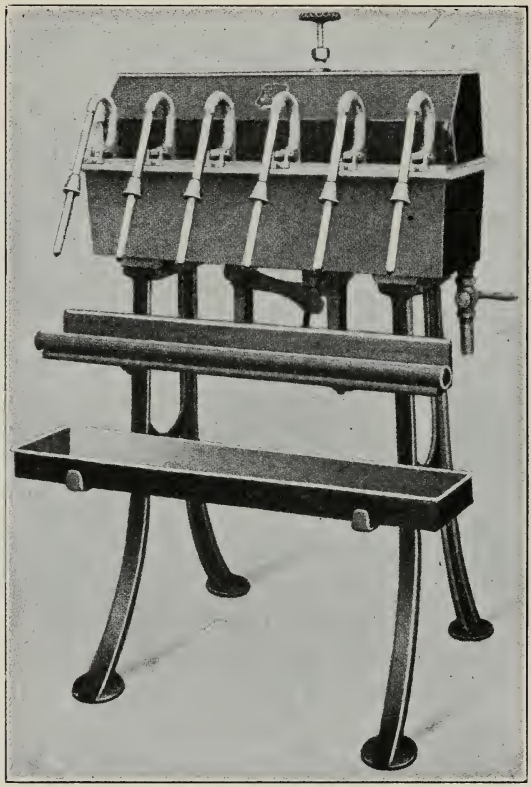


Fig. 18.—Bottling machine for fruit juice.

GRAPE JUICE MANUFACTURE

Qualities Desired in Grape Juice.—A red juice is commonly preferred, and the more intense the color the better. High acidity, that is, a tart flavor, is necessary in a successful product. Clearness is desirable, but not essential, although a heavy deposit of pulp detracts from the appearance of the bottled product. A slight cloudiness is not objectionable when the juice is put up in cans.

In adidtion to these qualities the juice must have a distinctive and pleasing flavor. If the product is to become popular this flavor must be very pronounced.

Varieties of Grapes for Juice.—At present the most popular juices are those made from the Concord and other closely related eastern (i.e., Labrusca) varieties. In California the Pierce Isabella is used as a substitute for the Concord, as it combines in a single variety high color, high acid, and the favored flavor of the Fox grape varieties. It may be grown most successfully in the coast counties.

None of the commonly grown Californian (European) varieties possess in a single variety all of the desired qualities. The Muscat has a strong flavor but is white in color and not very high in acid. When blended with suitable varieties of red wine grape juices a very excellent product, which compares favorably with Concord juice in color, acid, and flavor, can be made. It is believed that such a juice can become a strong competitor of eastern juices. The better varieties of red wine grapes such as Barbera, Valdepenas, St. Macaire and Crabbe's Black Burgundy, give better results than do the commoner varieties, such as Petite Sirah, Zinfandel, Alicante Bouschet, Carignane, and others, but these latter varieties also may be used successfully to blend with Muscat juice.

For the production of juices of delicate flavor, which will appeal to connoisseurs of fine wines, varieties such as Semillon, Franken Riesling, or Colombar should be blended with acid varieties, such as Burger or West's White Prolific.

Gathering the Grapes.—The composition of the finished juice is governed by the time of picking the grapes. Eastern varieties should be gathered at about 17° to 18° Balling as indicated by the Balling "sugar" tester shown in figure 19. This concentration is easily reached in California, but is difficult to obtain in eastern grape growing regions.

Muscat, Semillon, and other flavor grapes must reach the stage of maturity at which their flavor is well developed. This is 22° to 23° Balling. The acid grapes to be blended with the flavor grapes should have a good color but still be very sour; that is, about 18° Balling. With Zinfandel grapes, in order to obtain both acid and color, it will be necessary to gather the first crop at 20° Balling for color and at the same time enough of the second crop to impart a very tart flavor. Ordinarily the color and the acid varieties will have to be gathered several weeks before the flavor varieties have ripened sufficiently and their juice preserved and stored until it is to be blended with the flavor juice later.

A test of the acidity of the grapes is important. The finished juice should contain from .9 to 1.1 per cent acid expressed as tartaric acid. This test is simple and can be made with equipment and solutions which may be obtained from any chemical supply house. Names of these companies will be furnished upon request to Division of Viticulture and Fruit Products, University of California.

To make the test, measure 10 cubic centimeters of the juice by means of a 10 cc pipette into a tumbler. Add water to fill the tumbler one-quarter full. Add a few drops of phenolphthalein indicator solution. Fill a burette with tenth normal (N/10) sodium hydroxide solution and read the level of the liquid in the burette. Add the tenth normal sodium hydroxide solution slowly to the juice in the tumbler until a drop finally turns the liquid in the tumbler permanently pink. Read the level of the liquid in the burette again. The difference between the first and second readings represents the amount of solution needed to neutralize the acid of the juice. This figure multiplied by 0.075 will give the acidity of the juice in per cent. Example: first reading, 4.0; second reading, 15.5. Difference 11.5. Acidity = $11.5 \times .075 = .86$ per cent.

The grapes should be crushed as soon after picking as possible to forestall molding or souring. Only clean lug boxes should be used.

Crushing and Stemming.—The grapes must be thoroughly crushed. White grapes should not be stemmed because the stems aid in pressing. Red wine grapes should be stemmed for the reason that heating the juice later to extract the color will leach from the stems an astringent principle of disagreeable flavor.

Pressing.—White grapes must be as completely pressed as possible without heating. The color of grapes used for red juice is held in the skins and this must be extracted by heat. Therefore, such grapes are not finally pressed until the juice has been heated in contact with the skins.

Extraction of Color.—There are two methods in use for extraction of color. The most commonly used process consists of heating the mixed skins and juice in a large double jacketed steam-heated aluminum kettle to 160° F for a few minutes. The grapes are then pressed hot at once.

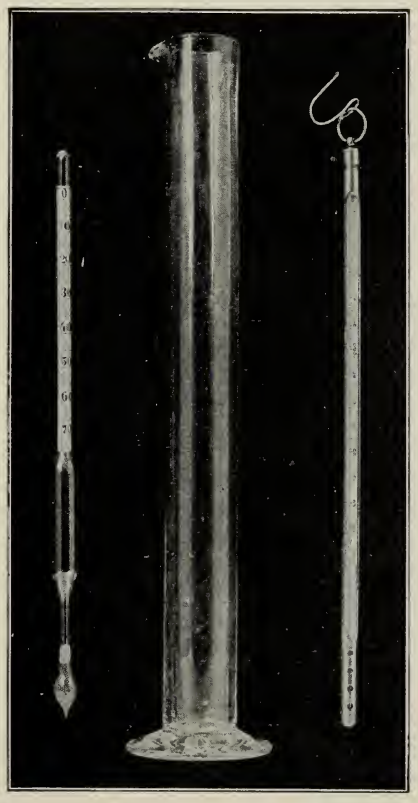


Fig. 19.—Balling hydrometer, hydrometer cylinder and thermometer for testing sugar content of juice.

The other method consists in first lightly pressing the crushed stemmed grapes to obtain one-half or two-thirds of the juice. The pomace (pressed skins and seeds) is thrown into a clean wooden vat. The juice is heated in one of the bulk pasteurizers previously described, to about 140° F and is then mixed with the pomace and allowed to stand until sufficient color is extracted. This will be four to eight hours. The skins and juice should be frequently stirred to hasten color extraction. The grapes may then be pressed. Heating destroys the slimy character of the crushed grapes and thus facilitates pressing so that the presence of the stems is not necessary.

The second method described above for color extraction has given the better results since overheating is avoided. High temperatures (150° F to 180° F) of mixed juice and skins cause the juice to develop a harsh flavor, probably because of materials extracted from the seeds. It has been found that temperatures for mixed skins and juice of 130° F to 140° F give the best flavor and at the same time permit of satisfactory extraction of color.

First Pasteurization.—The juice must be heated to coagulate proteins, which would cause the juice to be cloudy if bottled direct from the press. This is done by heating the juice to a temperature equal to or greater than the final pasteurizing temperature, otherwise the second heating would cause the juice to again become cloudy by the further precipitation of proteins. If crystallization of cream of tartar in the bottled product is to be prevented, the juice must be stored several months to permit this to separate before final bottling; and in order that the juice will not ferment during this storage it must be sterilized in or into sealed containers.

In some grape juice factories the juice is heated to a temperature of 175° to 190° F in aluminum kettles and then transferred at this temperature to glass carboys that are still hot from having been sterilized in steam. Any one of the continuous pasteurizers previously described may also be used. The carboys in either case are filled to overflowing and are then sealed with corks sterilized in scalding hot melted paraffin. The tops of the carboys and corks are then sealed with paraffin or wax.

In California 25- or 50-gallon oak barrels are often used instead of glass containers. The barrels must be sound and sweet. New barrels should first be treated with hot soda ash solution and several days' leaching with hot water to remove the oak flavor. Just before they are to be filled, the barrels are thoroughly steamed and the hot juice is filled into them. They are bunged tightly with ordinary shipping bungs and muslin. Both the bungs and muslin must be sterilized several minutes in boiling water before use. After filling and bunging, the barrels should be rolled slightly on their sides to permit the hot juice to further sterilize the bungs. The outside of the barrels should be thoroughly painted with melted paraffin or shellac to render the wood airtight. Barrels have been proved by repeated tests to be very much inferior to glass containers for storage because the materials extracted from the wood injure the flavor of the juice and permit browning through oxidation. Their use is *not* recommended if large glass carboys are obtainable.

Reclaiming Barrels.—Barrels which have become contaminated with oil, creosote, fish or other odoriferous substances can not be cleansed sufficiently to make them suitable for the handling of fruit juice. The delicate nature of fruit juices is such that a slight taint from such substances renders them unpalatable. Most barrels which have been used for fruit juice, syrups or concentrates, soda fountain syrups and vinegar can be reclaimed provided proper precautions are taken.

The following treatment has been found effective in cleansing barrels. Wash thoroughly by boiling with a weak lye solution. This can be done by filling the barrel with the lye solution or by making up the solution in the barrel itself; use about ½ ounce of flake caustic per gallon of water and run in a jet of live steam causing the solution to boil or remain near boiling for one-half to three-quarters of an hour. The effectiveness of this treatment can be increased by allowing the solution to remain in the barrel as long as time will permit, for example overnight. Then wash in a similar manner with fresh water to remove as much of the lye as possible. Soda ash may be used instead of lye. It has the advantage of not dissolving the wood fiber.

Follow this by soaking with a weak solution of hydrochloric, citric or tartaric acid to remove or neutralize the remaining lye. Then wash again with fresh water as before and dry. If compressed air is available, drying can be accomplished quickly and effectively by its use. Otherwise a final steaming to heat the barrel thoroughly will hasten drying. If climatic conditions are favorable this drying can be done in the sun.

Paraffining Inside of Barrels.—When the inside of the barrel is thoroughly dry, and not until then, the paraffin can be applied. For a 50-gallon barrel melt 3 or 4 pounds of paraffin. It will not require this entire amount to coat the barrel but an excess is necessary to insure a thorough coating. Heat the paraffin until it is smoking hot. Have only one bung hole open, preferably midway in the side of the barrel. Pour the hot paraffin into the barrel using a funnel. Provide for escape of air from the barrel around the funnel otherwise a dangerous spattering of the molten paraffin will occur. Place the bung in tightly and rock the barrel vigorously from end to end at the same time rolling it slowly until it has been rolled completely over thus permitting the paraffin to cover the sides completely.

Then turn the barrel on end and agitate it in such a way as to spread the paraffin over the head. Invert the barrel and repeat the

movement to cover the other head. Remove the bung and pour out the excess of molten paraffin, which can be returned to the heater to be used in the next barrel.

The amount of paraffin required for a barrel will be determined by the thickness of the coating, which is determined by the temperature of the barrel, of the molten paraffin and the speed of manipulation. A thin coat of paraffin for the inside is as effective as a thick coat and more economical.

The operation can be facilitated by the use of a spray machine designed for the purpose. If a large number of barrels are to be paraffined the initial cost of the spray machine would be offset by the saving in material.

Barrels treated in this manner, either spruce or oak, can be used to store juice in cold storage or for juice preserved by the addition of chemical preservatives. *Hot juice, however, will melt the paraffin and defeat the purpose for which the barrels were prepared.*

Storage.—Separation of cream of tartar is greatly hastened by low temperatures. Therefore large factories use refrigeration during storage. When refrigeration is not available the same results are obtained by simply storing the juice through the winter until February or March in a room which reaches outside winter temperatures. Tests show that storage until February 15 is sufficient. By leaving the doors open on cold nights and closed during the day, the desired temperatures will be readily attained.

The containers should be on shelves or racks well above the floor in order that the juice may be drawn off after storage.

Drawing off after Storage.—The settled juice after storage must be racked, that is, drawn off the sediment. This is most conveniently done by siphoning. A half-inch soft rubber hose attached to a short gooseneck of three-eighths inch tinned copper or brass pipe makes a convenient siphon. The gooseneck rests on the bottom of the carboy or tank, the inlet being slightly above the level of the sediment in the container. Thus the juice is drawn downward into the siphon and the sediment is not disturbed. The juice may be drawn off by means of a plain hose without use of gooseneck if care is exercised. A piece of bent half-inch glass tubing about three feet long, attached to a hose makes a convenient racking siphon.

Filtration.—Some grape juice manufacturers merely strain the juice from the storage containers through cloth. A much clearer product may be obtained by filtering through one of the filters previously described. If the racking of the juice after storage has been well done, filtration is rapid.

Bottling.—After removal of cream of tartar and after the juice is made clear as described above, it is filled into bottles. Quart bottles must be filled to within only about one and a half inches of the top, this space being necessary for expansion of the juice during pasteurizing. An automatic bottle filling machine will hasten this work. The bottles must be thoroughly washed before use and should, if facilities permit, be sterilized in live steam a short time before filling, but must be cool at time of filling to avoid breaking.

The caps used in sealing the bottles should be placed in live steam or boiling water for a period of about one minute just before use. This will destroy mold spores on and in the cork of the bottle cap. Nearly all spoiling of juice in bottles by mold growth is caused by the resistant mold spores to be found on all such non-sterilized caps. The cork is a poor conductor of heat and thus protects the spores during sterilization of the juice; hence the need of sterilizing the corks or caps before use.

Pasteurizing Bottled Juice.—The bottled juice must be sterilized at once by heat to prevent spoiling. A temperature of 165° to 170° F for thirty minutes in the bottles is necessary to insure complete sterilization of juice which is not carbonated. The bottles are placed in a horizontal position on the false bottom of the sterilizer in order that the juice shall be in contact with the cap and thus make certain that the inner cork disk of the cap reaches the sterilizing temperature of the juice. If the bottle is in an upright position the air space in the top of the bottle acts as an insulator and prevents the cap being thoroughly heated. The bottles are covered with water and the water heated by steam or direct heat to between 170° and 172° F and kept at this temperature 30 minutes. Tests have shown that there will be about 2° difference between the temperatures of the bottled juice and the surrounding water. Cooling after pasteurization may be hastened by gradually cooling the bath by slowly running in cold water.

The water is than drawn from the pasteurizer and the bottles placed in a room free from violent drafts of cool air; or may, if desired, be allowed to cool in the pasteurizer. The latter practice avoids the necessity of handling the hot bottles. Another type of pasteurizer is shown in figure 17. In this pasteurizer the bottles of juice are heated by sprays of hot water.

Storing Bottled Juice.—The finished juice should be held for at least four weeks at a warm room temperature to determine whether it will remain clear and free from mold.

Bottling Juice Without Removal of Cream of Tartar.—The juice may be bottled twenty-four hours after crushing of the grapes if bottled without storage to remove cream of tartar. The juice may be made clear by processes already described; may then be bottled and pasteurized, the total length of time from vine to bottle not exceeding three days. Such juice will, however, develop a crystalline deposit of cream of tartar. This does not affect the flavor, and injures the juice in no way, except in appearance. The deposit is small, but might cause the consumer to doubt the purity of the juice unless the label were designed to explain the presence and character of the crystals.

This method reduces the expense of manufacture and the investment in equipment. Juice so made is handled fewer times than that made by the usual methods and is therefore richer in flavor and of better color.

Carbonating Grape Juice.—Carbonated juices are always more popular than still juices for the same reason that sharp or sparkling cider is preferred to the juice fresh from the apple. Besides increasing the palatability of the juice, the carbonating greatly reduces the temperature necessary for sterilization. Juices that are lightly carbonated may be sterilized at 150° F or less.

A carbonated juice should be clear and free from sediment in order to be attractive.

Carbonating consists in impregnating the juice with carbonic acid gas and in bottling under a pressure of the same gas. Carbon dioxide, that is, carbonic acid gas, is sold in the liquified state in steel cylinders.

The solubility of the gas in the juice is greatly increased by low temperatures. A convenient and effective system of carbonating consists in chilling the juice to near freezing and in agitating the chilled juice in a strong, sealed container into which the gas is admitted under pressure. Fair results can be obtained by carbonating the chilled juice in open containers. Pressure gauges, safety valves, and automatic pressure controls should be used to avoid accidents from bursting of the container by excessive pressures. Fifteen to twenty pounds pressure per square inch will be sufficient. The juice after carbonating is filled directly into bottles and capped at once.

Another system of carbonating consists in impregnating the juice by aspiration; that is, the chilled juice is passed downward through a cylinder filled with glass or porcelain beads. The carbonic acid gas is admitted at the bottom of the upright cylinder. The gas is absorbed

by the stream of juice. The whole apparatus is under a pressure of carbon dioxide. The juice flows directly into the bottles under pressure.

A convenient and simple method for small scale operations is to place the juice in a heavy beer keg; connect a cylinder of gas to a carbonating inlet which may be purchased for such barrels; admit gas up to fifteen pounds pressure and agitate and roll the barrel for about fifteen minutes, admitting gas frequently to maintain the pressure at fifteen pounds. If the juice is cool, it may then be drawn off and bottled, but it will be necessary to admit gas to the barrel occasionally during filling of the bottles to maintain a constant pressure (fig. 20).

Fig. 20.—Simple device for carbonating fruit juice for small scale production.

The bottles of carbonated juice are sealed and sterilized at 150° F for thirty minutes. The bottles should not be handled while they are still hot because they will be under a dangerous pressure owing to expansion of the gas from heat.

Canning Grape Juice.—The time and expense of manufacture are greatly reduced if the juice is canned. Red juice tends to become blue or purple in color after canning, unless heavily lacquered cans are used. For this reason white juice has been more satisfactory than red juice for canning. Lacquered cans impart a disagreeable flavor.

The canning of white juice may well become an important industry for fruit canneries. A process suitable for commercial use is as follows: The grapes are crushed and pressed. The juice may be heated to 170° F and allowed to stand overnight to cool and settle, or may be passed at once through cooling coils after heating. The cool juice may be filtered roughly and filled into cans. A can syruping machine would make an excellent filling device. The filled cans may be passed through a cannery exhaust box slowly and heated therein to 175° F. The cans of hot juice may be capped at once and turned upside down to cool. Red juice may be canned in a similar manner but is not so satisfactory as the white.

A modified process consists in warming the filtered juice to about 160° F for 10 minutes to expel dissolved air, then filling into cans, sealing, and sterilizing in water at 175° F for 25 miuntes. Unless air is expelled from the juice before the cans are sealed, the juice will cause corrosion and perforation of the cans.

Another process in use for grape juice consists in heating the filtered juice to 175° F and filling into cans at this temperature and sealing without further treatment. Red grape juice has been canned experimentally by heating the crushed grapes to 160° F, pressing, filtering and canning in enamel lined cans as directed above.

Since less attention is given to clarification and containers are cheaper, canned juice may be produced with less expense. It should be possible to sell it for 30 cents or less per quart can at retail if grapes may be had at $40 a ton or less. At $40 a ton for grapes the raw material for one quart of juice costs 6¼ cents. The can and label will cost about 4 cents, the cost of manufacture not more than 2 cents and the case about 2 cents a quart. This gives a total cost of about 14¼ cents a quart.

Pasteurizing Juice in Barrels.—Either red or white juice may be pasteurized into sterilized barrels as described elsewhere, at 175° F. The barrels must be bunged at once with sterilized bungs and the outside of the barrels coated with paraffin, shellac or other impervious coating to prevent infection. Such juice may be exported to foreign countries for various purposes or sold in the United States for use in large soft drink dispensaries or at picnics, etc., where an inexpensive juice of good quality is desired. Some juice factories store juice in bulk in this manner to permit settling before filtration and bottling.

Preservation of Juice with Sulfurous Acid.—If grape juice is stored in a cool place (60° F to 65° F or less), it may be kept for at least one year by the addition of one-tenth of 1 per cent sulfurous acid, which corresponds to 12½ ounces of sulfurous acid; or about

1¾ gallons of *commercial* 6 per cent sulfurous acid solution to 100 gallons of juice. Juice stored at higher temperatures requires proportionally larger amounts of the sulfurous acid to prevent fermentation.

Juice preserved in this way cannot be used for drinking purposes until the sulfurous acid is removed. This can be done by heating the juice to 160° F, and at the same time passing a violent stream of air through it for about an hour and a half. A better method of removing the sulfurous acid is to heat to boiling in a vacuum pan and pass a current of steam through the boiling juice for 30–40 minutes. This removes enough of the sulfurous acid to permit the juice to be used for drinking purposes, syrup making, or vinegar manufacture; or the juice after removal of the preservative may be sterilized in barrels. J. H. Wheeler of St. Helena, the California Grape Products Company of Ukiah and others have preserved and successfully treated juice in this way on a commercial scale for several seasons.

This method of preservation makes it possible to utilize the storage tanks of wineries to good advantage and for a grape syrup factory to have juice on hand throughout the year at little expense.

Juice preserved with sulfurous acid should not be allowed to come in contact with iron or copper; only aluminum, tin or glass should be used. A wooden vat and aluminum steam coil may be used to heat the juice during the removal of the preservative; or a large glass-lined steam jacketed vat of the type used for concentrating tomato products is excellent. An air compressor of rather large capacity is also necessary. This should be connected to an aluminum or block tin pipe leading to the bottom of the heating vessel, or a piece of steam hose may be used to deliver the air.

Red juice when preserved with sulfurous acid becomes almost white in color, but when the sulfurous acid is removed most of the color returns.

Aeration does not remove all of the sulfurous acid and if such juice is offered for sale it must bear the statement that it contains sulfurous acid.

Home Methods of Grape Juice Making.—A red juice is more satisfactorily made in the kitchen than a white juice. The grapes should not be too ripe but should be still rather tart when picked. A mixture of Muscat and red wine grapes gives a very satisfactory juice.

Crush the grapes in a small household size crusher or merely crush them with the hands into an agateware, tin, or aluminum kettle.

Heat slowly with stirring to 150° F; a dairy thermometer is useful for testing the temperature. Set aside for about two hours. Place in a jelly bag or in a heavy cloth in a small press. Allow to drain into a pan and press the skins and pulp.

Fig. 21.—Small hand-power capper.

Strain through a cloth or felt bag. Fill into clean scalded bottles. Cork bottles with corks that have been boiled five minutes in water. Tie the corks down with string. Place the bottles horizontally on a false bottom in a wash boiler or large kettle. Fill the vessel with water and heat the water to 175° F for thirty minutes. Remove bottles and seal corks with melted paraffin. Crown finish bottles, crown caps and a small hand-power capping machine may be used. See figure 21, illustrating this capper.

The strained juice prepared as directed above may be heated to 180° F and poured into hot, scalded Mason or glass top jars. Scalded rubbers and caps are then put in place, the jars sealed and turned upside down to cool. This method is simple and effective. Never heat grape juice to the boiling point.

Costs and Returns on Grape Juice.—Judging from the results of experiments at the University Farm and at Berkeley it would be possible to erect a small grape juice plant for about $1,000 exclusive of barrels, bottles, or other juice containers. This plant would have a maximum capacity of about five tons of grapes a day or about one hundred tons in a season of twenty days; or would produce 15,000 to 20,000 gallons of juice in a season. It consists of a shed; a small continuous pasteurizer made of 50 feet of five-eighths inch aluminum pipe coiled inside a 50-gallon barrel; a 3-horsepower boiler (5-horsepower is better); a cement vat 5 feet long by 2½ feet wide by 2 feet deep with steam coil for pasteurizing bottled juice; a small pulp filter; a foot-power Crown bottle capper; a hand-power grape crusher; a medium size hand-power screw basket press and miscellaneous utensils such as fiber tubs, pails, dippers, hose, etc. To this must be added glass carboys for 15,000 gallons of juice, 60,000 quart bottles or their equivalent in other sizes; caps, labels and shipping boxes. The estimated cost per quart bottle is as follows:

Grapes at $40 per ton and yield of 600 quarts per ton	$0.0625
Bottle at 4½ cents	.0450
Caps at 30 cents per gross	.0020
Labels at $10 per thousand	.0100
Cost of handling at 16 cents per gallon	.0400
Cost of packing for shipment	.0300
Total	$0.1895

Total cost per quart, about 19 cents, allowing no charge for interest on investment or depreciation.

UNFERMENTED APPLE JUICE

The manufacture of apple juice has become an important industry in the Pacific Northwest, where several breweries have been successful in producing a high class unfermented cider. Several very successful factories of moderate size exist in California. Very large quantities of cider in bulk either fresh or benzoated are consumed.

Of the bottle juices the carbonated cider is most in demand and must be brilliantly clear.

The general principles of preparation are similar to those used in making grape juice. Apple juice is more easily injured in flavor by heat than is grape juice, and therefore requires greater care.

Varieties of Apples Used.—Apples of sprightly to acid flavor are best, provided they are ripe and possess a full apple flavor. Of the commercially grown varieties of California, the Yellow Newtown has been found satisfactory. The Bellflower is of poor flavor. The Gravenstein is of fair quality for juice but not so good as the Newtown. Northern Spy, Winesap, and other varieties of sprightly flavor are excellent, but scarce in California. Varieties of very low acid, such as the Tolman Sweet, are of little value and produce juices which are difficult to sterilize. Varieties also which may have sufficient acid but which are of poor flavor are not successful. To this class would belong the Bellflower and Ben Davis.

The apples should be mature enough to possess their full flavor, but should not be over-ripe, because of the decrease in acidity after maturity is reached and because juice from over-ripe fruit is "gummy" and very difficult to filter.

Only clean, sound fruit should be used. This usually means that the fruit should be carefully sorted and washed before crushing. See illustration of fruit washer, figure 1.

TABLE 2

COMPARATIVE QUALITIES OF JUICE FROM VARIETIES OF COMMERCIALLY GROWN APPLES (AFTER GORE)

Variety	Source	Quality of sterilized juice
Yellow Newtown (syn. Albemarle Pippin)	Waynesboro, Va.	Juice very palatable; distinguished from the fresh only by the slight cooked taste and a little bleaching or lightening of color.
Ben Davis	Waynesboro, Va.	Quite unpalatable; lacking in distinctive apple flavor.
Winesap	Waynesboro, Va.	Very palatable; the fruity flavor somewhat impaired by sterilization; slight bleaching noticeable; very little cooked taste.
Tolman (syn. Tolman Sweet)	Halls Corners, N. Y.	A very dark colored, thick juice; very sweet and insipid.
Northern Spy	Halls Corners, N. Y.	Very fine in flavor, a fine rich juice, showing slight bleaching and hardly detectable cooked flavor.
Baldwin	Halls Corners, N. Y.	High in quality, very palatable, slightly bleached and with slight cooked flavor.
Roxbury (syn. Roxbury Russet)	Halls Corners, N. Y.	A heavy, rich juice, very palatable; slightly bleached and with very slight cooked flavor.

Tables 2 and 3 give the comparative qualities and composition of juice from varieties of commercially grown apples.

TABLE 3

COMPOSITION OF UNFERMENTED APPLE JUICE FROM DIFFERENT VARIETIES OF APPLES (AFTER GORE)

Variety	Total solids *Per cent*	Acid as malic *Per cent*	Reducing sugar *Per cent*	Total sugar *Per cent*
Yellow Newtown (syn. Albemarle Pippin)	12.35	0.53	9.15	11.58
Ben Davis	12.05	0.48	7.86	10.05
Winesap	11.64	0.46	9.06	10.02
Tolman (syn. Tolman Sweet)	15.63	0.13	9.92	13.95
Northern Spy	14.90	0.61	8.52	12.82
Baldwin	14.31	0.63	7.33	12.22
Roxbury (syn. Roxbury Russet)	16.86	0.70	7.46	13.81

Removal of Arsenical Spray Residue.—Until recently pure food and drug authorities did not insist on the removal of arsenical and lead spray materials from apples to be used for cider.

Recent federal regulations, which place the tolerance of lead arsenate at 1/100 of a grain to a pound of fruit are now being rigidly enforced and necessitate changes in the former methods of washing apples. Lead arsenate cannot be removed sufficiently with water to meet the requirements of the law. However, its removal from apples which are to be used in the manufacture of cider or vinegar is a less serious problem than its removal from fruit which is to be marketed fresh, because stronger washing solutions can be used with more vigorous agitation with cider apples.

Two methods of removing of spray residues are as follows:

"Dissolve 4 pounds each of soda ash (Na_2 CO_3) and common salt (NaCl) in 12.5 gallons of water. Maintain the temperature at 100° F. Pass the apples through this solution agitating gently. Allow fruit to remain in the solution at least 5 minutes but not more than 10 minutes. Rinse with fresh water."[2]

Another method consists in washing with dilute hydrochloric acid. "Of the many compounds tested none has proved to be superior to hydrochloric acid. When used at concentrations varying between one-fourth of one per cent and two per cent (actual acid) this compound has been found to be very effective in the removal of arsenical

[2] Headden, W. P. Removal of arsenate of lead from sprayed fruit. Colo. Agr. Exp. Sta. Press Bul. 63: 1–4. 1926.

residue from both apples and pears. Indications are that this acid will prove even more efficient when adequate washing devices are perfected.''[3]

Wiping has been resorted to by many for the removal of spray residues. The expense of hand wiping is excessive and is not practical. Numerous ingenious devices for wiping mechanically have been invented, some of which are very effective. The manufacturers of fruit handling equipment can furnish machines especially designed for this work.

Crushing and Pressing.—Apple tissue is firm and tough and the cells possess heavy walls. Consequently crushing must be thorough and pressing severe to obtain a high yield of juice. Crushing too fine, however, causes the pulp to be too soft to press without danger of breaking the press clothes. Pieces ranging in size from one-eighth to one-half inch in diameter are satisfactory. The crusher can be set to grind to any desired degree of fineness.

The crushed fruit is placed in heavy coarse-weave cloths and the fruit is enclosed by folding the cloth. Each cloth of fruit is placed between racks made of hardwood slats. Pressure is applied usually by a hydraulic pump. A pressure of at least 500 pounds per square inch is necessary for the best results. A ton of apples should yield 160 gallons of juice if well pressed. The pomace, that is, the press cake, will yield more juice if broken and pressed a second time, this juice being preferably used for vinegar. By using a pomace picker or crusher (fig. 22) the yield of juice may thus be increased greatly.

Clearing the Juice.—A common method of clearing the juice consists in heating to precipitate proteins and gums, cooling the heated juice, and filtering until clear. Methods of filtering described for grape juice can be used for apple juice.

One of the most successful methods consists in mixing 1–2 per cent by weight of refined ''Filter-Cel'' with the juice and filtering in a filter press. Two or more filtrations are usually necessary. If the juice is to be carbonated before bottling it needs to be heated to from 150° to 155° F only; but if to be bottled without carbonating it must be heated to from 165° to 170° F. In other words, the juice is heated before filtration to a temperature equal to or greater than that to be used in sterilizing the juice in the final bottles because if it is heated to a lower temperature before filtration the higher temperature during final pasteurizing may cause the juice to become cloudy through

[3] Robinson, R. H., and Henry Hartman. A progress report on the removal of spray residue from apples and pears. Oregon Agr. Exp. Sta. Bul. 226: 7–46. 1927.

further precipitation of protein. Some factories filter the fresh unpasteurized unheated juice and bottle without the preliminary pasteurizing noted above using only the final pasteurizing. This can be safely done with juice from yellow Newtown apples.

Aluminum, tin, glass, silver and monel metal surfaces may be used in contact with hot apple juice with safety. Most other metals are acted upon by the acid of the juice.

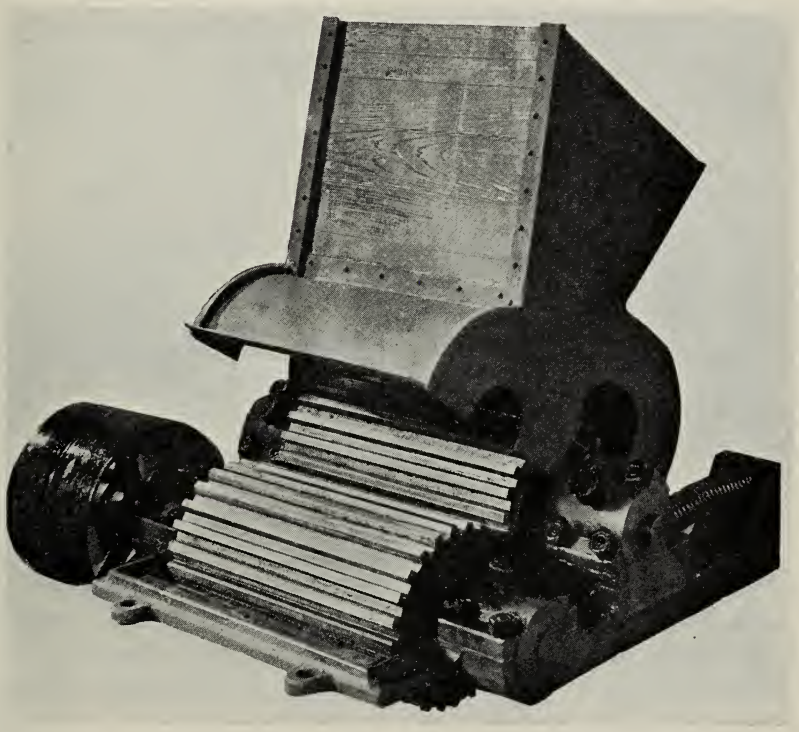


Fig. 22.—Pomace picker or crusher.
(Courtesy, Hydraulic Press Mfg. Co.)

Carbonating Apple Juice.—The methods described for carbonating grape juice are also suitable for apple juice.

If carried out at room temperature the juice should be carbonated to about 15 pounds pressure. If the juice is first chilled to 32°–36° F it will absorb the gas more readily and carbonating to 5 pounds pressure in a clean barrel will be sufficient; or merely slowly passing the gas through the cold juice will cause it to absorb enough to impart a sharp flavor to the bottled juice, although this method is

wasteful of gas. It is preferable to use some form of carbonating machine designed for the purpose.

Apple juice is greatly improved by carbonating and all such juice for sale in bottles should be so treated.

Pasteurizing.—Carbonated juice may be sterilized at 150° F for thirty minutes. If the juice has not been carbonated it should be heated to 170° F for thirty minutes. Carbonating checks the development of mold thereby making possible a lower sterilization temperature.

Spoiling of Apple Juice by Mold.—Bottle caps are the usual source of infection. Caps are readily sterilized before use by immersing them in boiling water for one minute. This sterilization will greatly reduce loss from mold growth. Bottles should also be sterilized in steam or hot water before use.

Canned Apple Juice.—Apple juice retains its flavor well in cans and this method offers the cheapest way of placing the juice on the market in small containers in sterilized form. Unless properly canned, cider will attack the tin plate vigorously with the formation of hydrogen gas, and swelling—or even perforation of the cans.

Canned juice need not be perfectly clear, but should not show a heavy deposit in the can. The following method has proved successful:

The fruit is crushed and pressed. The juice is then filtered through felt filter bags or heavy duck bags to remove particles of pulp. Place cold juice in plain tin cans (never use enamaled cans) and heat in a steam box, that is in live steam, until the juice in the center of the can reaches 180° F. Seal immediately. Be certain that the can is completely full so that after it is sealed no head space remains. Cans which are not completely full should be emptied and the cider used in the next lot. Sterilize cans at 175° F for 15 minutes. Chill and store in a dry place.

After cooling the juice contracts in volume leaving a head space of about ¼ inch in depth.

Another method in use under commercial conditions is the following: The fresh juice from the press is strained through several layers of cheese cloth; is then heated to 180° F and run directly into cans which are filled level full. The cans are sealed immediately and no further heating is given. Usually such juice is not so clear as that made by the first process but is of good flavor.

LOGANBERRY JUICE

Loganberry juice has become very popular during the past few years and is now produced on a large industrial scale in Oregon, making the growing of this fruit very profitable. The development of loganberry juice manufacture is largely due to work of Professor C. I. Lewis, formerly of the Oregon Agricultural College. The juice is of deep red color, very rich flavor, and high acidity. Thoroughly ripe fruit gives the best juice, that from under-ripe berries being light in color, excessively tart, and astringent in flavor.

Extraction of Juice.—The juice is best extracted by a combination of crushing, heating and pressing.

The berries may be crushed in a grape crusher, but wooden or tinned rollers should be used because the acid of the juice attacks iron. The crushed fruit should be heated in tin-lined or glass-lined kettles, with constant stirring, to about 140° F and pressed at once. If aluminum kettles are used care should be taken not to allow juice to stand in them because aluminum is rapidly attacked by most acid juices. Long continued heating extracts tannin and disagreeable flavors from the seeds. The rack and cloth type of apple press should be used for pressing.

Clearing the Juice.—The juice should be cooled after pressing and before filtration. Because the juice is rich in pectins and gums it is difficult to filter. Several filtrations through pulp or asbestos are usually necessary to render the juice bright. In the experimental work a clear juice was obtained by filtration through a felt bag and subsequent filtration through cotton fiber pulp filter.

Clarification may also be accomplished as described for grape juice; that is, by sterilizing the juice into glass carboys, allowing it to settle several weeks, drawing off from the sediment, and filtering.

Preparing Filtered Juice for Bottling.—The filtered juice is bottled in three forms: (1) natural juice undiluted and unsweetened, (2) diluted, sweetened, and (3) sweetened but undiluted. The sweetened undiluted juice is the best. Sugar helps to retain the fresh berry flavor and prevents the development of a bitter, astringent flavor noticeable in unsweetened juices after several months storage. The amount of sugar added is enough to increase the Balling degree of the juice to about 45 per cent, which is approximately 3½ pounds of sugar to each gallon of juice. Sweetened loganberry juice is diluted with about two volumes of water (preferably carbonated) when served.

Bottling and Sterilizing.—The bottles are filled with cold juice and capped with caps sterilized one minute in boiling water. The juice may be sterilized by heating in water to 170°–175° F for thirty minutes. Carbonating before bottling reduces the temperature of sterilizing and improves the quality of the juice.

The process of manufacture is very simple; little equipment is needed and the quality of the product is high. Its manufacture should therefore prove a profitable undertaking for growers or growers' organizations.

POMEGRANATE JUICE

When properly made, pomegranate juice is of a brilliant purplish red color and perfectly clear; its flavor is pleasing and it blends well with other fruit juices, besides making a very pleasant beverage of itself when diluted and sweetened. Ordinarily it will be too tart and the flavor is not retained very satisfactorily unless the juice is sweetened before bottling.

Extraction of Juice.—The "rag" and peel of the pomegranate contains so much tannin that juice from these portions of the fruit is so "puckery" that it is undrinkable. The desirable juice is in the arils or "kernels." The problem is to separate these from the peel and "rag." It has been found that the smallest amount of tannin in the juice and the largest yield of juice is obtained when the whole fruit is placed in a rack and cloth, or basket type press, and pressed without previous crushing. Yields of about 90 to 100 gallons per ton have been obtained.

Clearing the Juice.—It was found that the juice could be easily clarified by heating, settling, and filtration. The freshly pressed juice is heated to 140°–165° F and allowed to cool and settle for 24 hours. The settled juice is racked from the sediment and filters very quickly. Probably the high tannin content of the juice favors this natural clarification.

Addition of Sugar and Sterilizing.—If the juice is very tart, sugar should be added to increase the concentration to about 35°–40° Balling. If the fruit is very ripe, sugar addition to increase the juice to 30° Balling will be sufficient. By tests made upon measured samples the proper amount of sugar can be quickly determined. Roughly, 2 to 3 pounds of sugar to each gallon of juice will be sufficient.

Sweet red grape juice from thoroughly ripe red wine grapes and made as described under grape juice in this publication may be added to pomegranate juice with pleasing results. The blend is less

harsh than the straight pomegranate juice and has much more character than plain red juice from wine grapes. E. M. Chace of the United States Department of Agriculture Citrus By-products Laboratory of Los Angeles has made a number of pleasing combinations of pomegranate juice with other juices, especially grape fruit juice.

Bottling, capping and sterilizing at 175° F for 30 minutes are carried out as described for grape juice.

CITRUS FRUIT JUICES

Citrus juices when preserved by pasteurization do not retain their flavor satisfactorily. Heavy sweetening, or concentration before pasteurization, enables these juices to better retain their flavor.[4] Preservation by storing in sealed containers at 15° F, or lower temperatures, retains the flavor very well. For small factories or for home preparation the sweetened juices are recommended.

Raw Materials.—In citrus districts packing house culls are generally used as raw material. A still lower grade of fruit is that known as "commission merchant culls" that are left after the packing house culls have been sorted by peddlers or commission merchants. This grade of culls usually contains a considerable quantity of decayed fruit "black hearts" smutty fruit and fruit otherwise unfit for juice purposes. This unfit fruit must be sorted before it is used for juice. It is not possible to prepare a first class juice from such low grade of fruit.

"Grove run" fruit is sometimes used by large producers of citrus juices. It is often necessary to buy fruit in this way to insure an adequate supply.

Sorting and Washing.—The decayed and moldly fruit must be discarded. Washing is desirable in order to remove mold spores, dust, smut or other foreign matter adhering to the skin. This is done best by any of the citrus fruit washers used in packing houses.

Extraction of Juice.—Where there is no objection to the presence of oil and bitterness from the peel in the juice, the fruit can be run through the machine illustrated in figure 5, which both crushes and presses. However, most consumers do not like the strong orange oil flavor and bitter taste from the peels. The presence of the oil and bitterness can be avoided as follows: The fruit is cut in half and juice is extracted by use of the revolving cone extractor illustrated in

[4] Directions for concentrating fruit juices are given in: Irish, John H. Fruit juice concentrates. California Agr. Exp. Sta. Bul. 392:1–20. 1925.

figure 23. Extraction with this device is called "burring." To remove coarse particles of pulp the juice should be strained through a fine screen or coarse cheese cloth.

Preservation of Unsweetened Juice.—If facilities permit, the juice should be treated as follows in order to minimize undesirable changes in flavors: Immediately upon extraction from the fruit the juice is

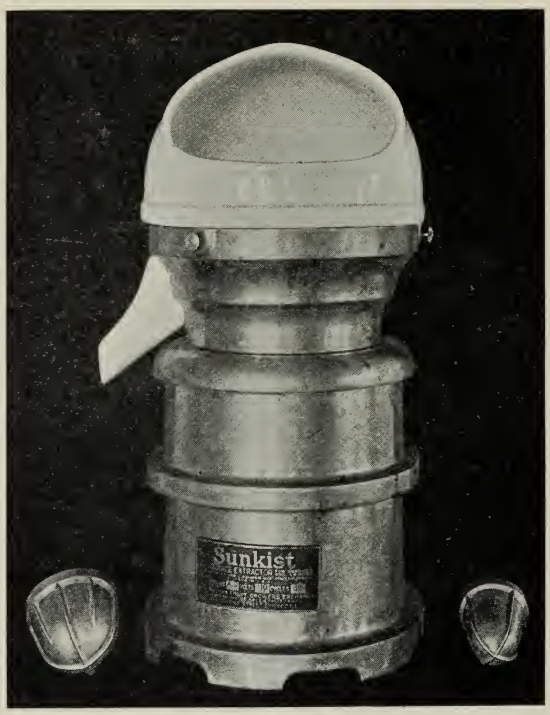


Fig. 23.—Revolving cone citrus juice extractor.

heated to 180° or 200° F and then chilled immediately to 40° F, or below. This quick process is known as "flash pasteurization." The juice may be heated in the continuous pasteurizer (fig. 8) and cooled in aluminum or tin coils surrounded by circulating cold brine and ammonia. Such cooling equipment can be purchased from dairy supply companies.

Juice treated in this way can be held in cold storage in closed containers for several weeks with but little deterioration. The taste of juice treated in this manner is slightly different from that of juice freshly extracted but the change in flavor is not objectionable. For

small scale production the flash pasteurization and cooling described above are not feasible and the sweetened juice process is recommended in such cases.

If cold storage is available, storage at a freezing temperature is recommended. Glass containers or double enameled tin cans may be used as containers. These should not be filled completely; considerable space should be left for expansion during freezing. The hardening room of an ice cream factory or the freezing storage room of a cold storage warehouse make ideal storage for citrus juices.

The juice may be bottled and pasteurized as described for apple juice but the flavor soon deteriorates.

Preservation by addition of one-tenth of one per cent sodium benzoate is possible but is not recommended except for low grade juice in barrels. One-tenth of one per cent corresponds to about 7 ounces of sodium benzoate to 50 gallons of juice.

Sweetened Citrus Juices.—A fairly satisfactory sweetened juice for the preparation of beverages can be prepared by mixing 1 part lemon juice and 3 parts orange juice and adding about 4 pounds of sugar to a gallon of this mixture. To preserve the juice, bottle it and pasteurize it as directed for apple juice that is at 175° F for 30 minutes. To use, dilute with water to taste. In general this method is the most satisfactory for preparing citrus juice beverages.

This product usually retains a pleasing flavor for three months or longer when stored at ordinary temperatures. If bottled, pasteurized and stored at 32° F it retains its flavor for at least a year. Citrus juices and syrups are discussed further in the next section of this circular.

FRUIT JUICE BEVERAGES

Some fruit juices, apple and certain varieties of grapes, are suitable for beverages as they are taken from the fruit. Others require dilution with water and sweetening by the addition of sugar to make them into palatable drinks, while still others require also carbonation.

The following portion of this publication is devoted to the preparation of beverages from fruit juices and concentrates.

There is consumed annually in the United States about 8,000,000,000 bottles of carbonated beverages, or about 80 bottles per capita. Very little of this contains an appreciable proportion of real fruit juice. If as little as one-fourth of the above mentioned quantity of carbonated beverages were made from real fruit juice, there would not be

enough cull fruits for the purpose. The fact that much cull fruit is now allowed to go to waste is proof that relatively little is used in carbonated beverages. Investigations have fully demonstrated the practicability of utilizing a larger proportion of fruit juices in such beverages without greatly increasing the cost. Fruit beverages are not only more palatable but are more healthful than the synthetic fruit imitation beverages. In California at least there is no excuse for the imitation fruit beverages.

The nature of the fruit and the content of the juice determine the method of preparing the juice. The juices of apples and certain varieties of grapes are suitable without modification for preparation of carbonated beverages. Others such as those from citrus fruits (grapefruit, lemon, lime and orange), pomegranates and most varieties of berries require dilution with water and the addition of sugar to make them suitable for the purpose.

WATER SUPPLY FOR BEVERAGES

The water supply is often a source of trouble in the preparation of bottled fruit beverages. Water from natural sources contains varying amounts of dissolved mineral salts and organic material. Unless these are removed natural water is usually unfit for use in preparing bottled beverages because of clouding of the beverage through precipitation of mineral salts.

There are a number of water purifiers on the market for preparing water for use in beverages. Most of these are satisfactory if properly operated. A proprietary water softener, filled with zeolite water softening material, has been used with Berkeley water, and found satisfactory for bottled beverages. The names of manufacturers will be sent on request.

Distilled Water.—Distilled water is more satisfactory than untreated water, or that which has been filtered. A water still of any desired capacity can be installed at a moderate cost. Owing to the fact that there is always a demand for distilled water for use in automobile and radio batteries it is possible in some communities to make the supplying of these demands a profitable side line.

Low Pressure Carbonating System.—Many producers of carbonated beverages use the low-pressure system of carbonating. The syrup and water are mixed in a large tank of water at or near the freezing point of water 32° F. At this low temperature the solubility of carbon dioxide is much greater than at room temperature. Glass

lined steel tanks are generally used for carbonating liquids at low pressure. This method greatly simplifies bottling equipment and operations and gives a product of more uniform character and gas pressure. Liquids carbonated and bottled by the low pressure system

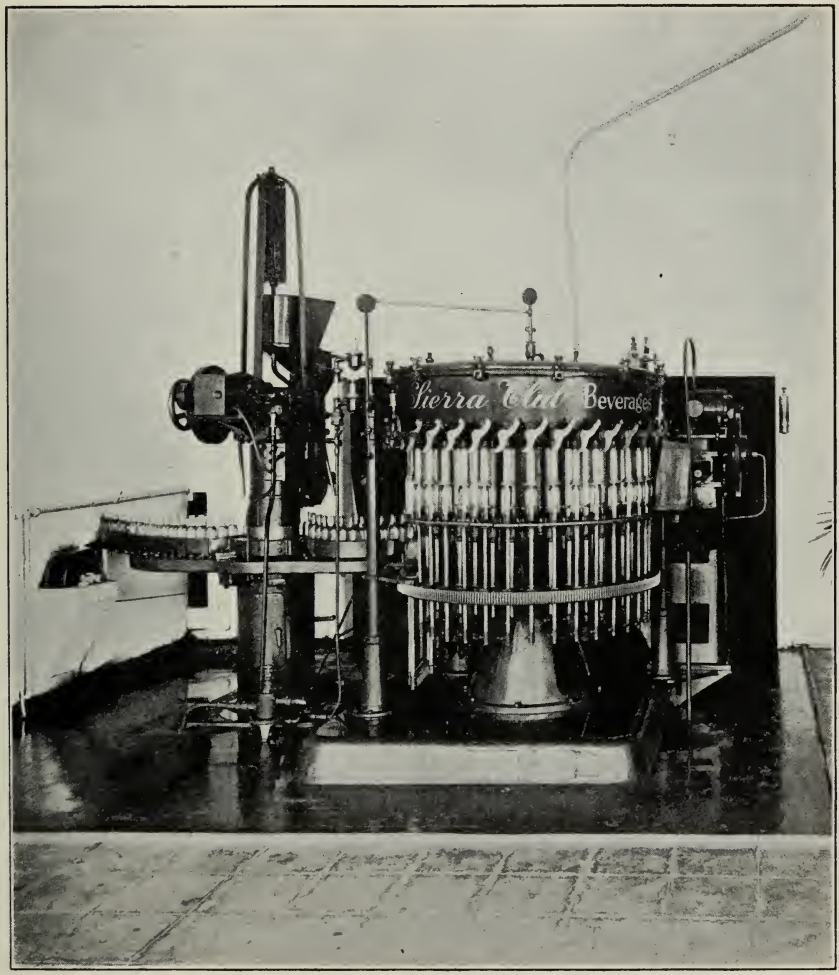


Fig. 24.—Low pressure bottling machine and bottle sealer.
(Courtesy, Henry Brown Company, Glendale, Calif.)

do not foam so excessively during bottling as those carbonated at high pressure at room temperature. A large size low pressure carbonating machine is shown in figure 24 and a carbonated water storage tank in figure 25.

High Pressure Carbonating System.—Most small producers of carbonated beverages use the high pressure carbonating system. A high pressure carbonating machine is shown in figure 26. This small carbonator has a capacity of about twenty gallons of water or juice an hour. This machine consists of a tin-lined heavy walled steel

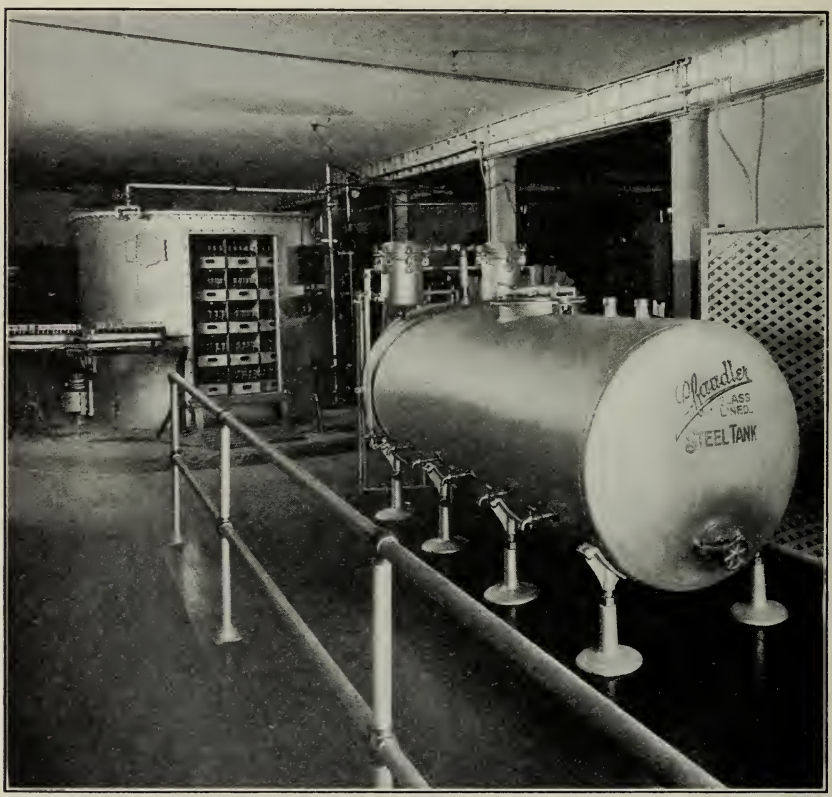


Fig. 25.—Carbonated water storage tank and continuous bottle pasteurizer. (Courtesy, Henry Brown Company, Glendale, Calif.)

cylindrical tank fitted with a stirrer and a small force pump. The carbonating chamber holds about five gallons of water. Water can be forced by the pump into the cylinder against pressure of carbon dioxide gas.

Carbon dioxide gas is admitted to this cylinder from a cylinder of the liquified gas through a regulating valve by means of which any desired pressure of gas can be maintained in the carbonator. At the same time the water or the juice is pumped and sprayed under

pressure into the carbonating chamber and is mixed with the gas by the stirring device. The pump and stirrer are operated by a small electric motor which is controlled by an automatic switch. The switch automatically cuts off the current to the motor, when the carbonating chamber has been filled with liquid.

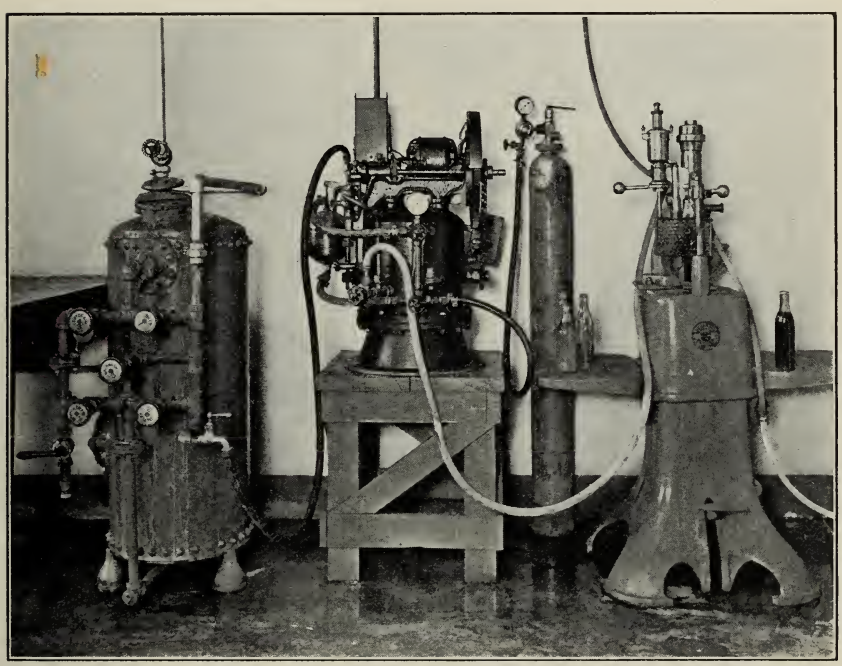


Fig. 26.—Water softening, carbonating, and bottling equipment used in the Fruit Products Laboratory, University of California.

TABLE 4

Showing Relation Between Pressure, Volumes of Gas and Temperature of Water in Carbonating Beverages

Carbonating pressure, 40 pounds		Carbonating pressure, 50 pounds		Carbonating pressure, 60 pounds		Carbonating pressure, 70 pounds	
Degrees Fahr.	Volumes of gas (CO_2)	Degrees Fahrenheit	Volumes of gas (CO_2)	Degrees Fahrenheit	Volumes of gas (CO_2)	Degrees Fahrenheit	Volumes of gas (CO_2)
32	6.2	32	7.3	32	8.8	32	9.6
40	5.4	40	6.2	40	7.2	40	8.0
50	4.4	50	5.2	50	6.0	50	6.2
60	3.7	60	3.7	60	4.2	60	4.6
70	2.7	70	3.2	70	3.6	70	4.0

There is a definite relation between the pressure (pounds per square inch) or of the volumes of carbonic acid gas and the temperature of the water used in carbonating. Table 4 shows this relation.

An example will serve to illustrate its application. Suppose you desire about 60 pounds pressure in the carbonated beverage. If the temperature of the water is 60° F then it will require 4.2 volume of gas.

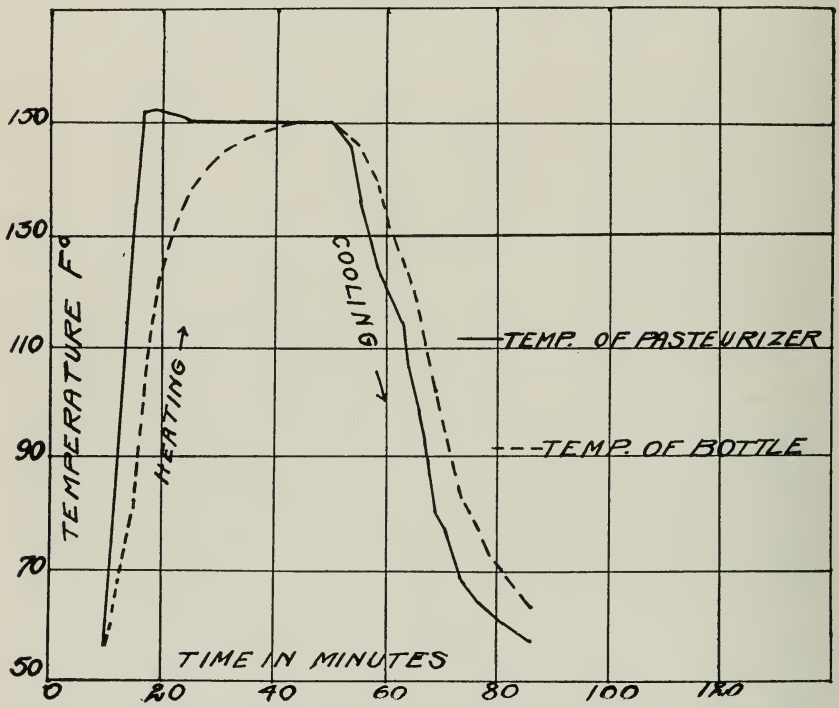


Fig. 27.—Curves showing rates of heat penetration and cooling of bottled beverages.

PRESERVATION OF BEVERAGES AND BEVERAGE BASES

Beverages, syrups and sweetened juices can be preserved by pasteurization, cold storage or preservatives. Where practicable, pasteurization is recommended in preference to the other two methods.

Preservation by Pasteurization.—Carbonated bottled beverages, owing to the presence of carbon dioxide, will not support mold growth. This fact greatly simplifies pasteurization as a temperature of 150° F is sufficient to destroy yeast, the only microörganism capable of developing in such beverages. Pasteurization is conducted

as described elsewhere in this circular, at 150° F for 30 minutes. In the investigations approximately 15,000 bottles of carbonated beverages were pasteurized in this manner without subsequent loss by molding or fermentation.

Large continuous pasteurizers are used in large bottling establishments. Small scale bottlers may make use of the simple wooden vat pasteurizer described under "Bottle Pasteurizers."

TABLE 5

Rates of Heat Penetrarion and Cooling of Eight Ounce Bottles of Fruit Beverage

Time in minutes	Temperature °F., of pasteurizer	Temperature °F., of bottle (average of two bottles)
0	56	58
5	134	82
7	152	102
10	152	122
15	150	137
20	150	144
25	150	147
30	150	149
35	150	149
37	150	150
Cooling after pasteurizing		
0	150	150
3	146	148
5	136	146
8	124	140
10	122	131
13	106	124
15	98	118
18	80	102
20	76	95
23	68	83
26	64	77
28	62	72
30	60	70
35	57	63

Sweetened juices and syrups in quart or smaller containers must be pasteurized at 175° for 30 minutes, and for 60 minutes in gallon containers.

Typical rates of heat penetration and cooling are given in table 5 and in figure 27.[5]

[5] For further data on rate of heat penetration see: Irish, J. H., M. A. Joslyn and J. W. Parcell. Heat penetration in the pasteurizing of syrups and concentrates in glass containers. California Agr. Exp. Sta. Hilgardia 7:183–206. 1928.

Preservation by Cold Storage.—All juices and syrups can be held indefinitely in fresh condition in sealed containers at 0–10° F. Enamel lined and outside enamel coated 5-gallon friction top cans such as shown in figure 28 are very suitable for the purpose. Paraffin lined barrels and 5-gallon glass carboys can also be used. The containers must not be completely filled because on freezing the liquid expands. About 10 per cent of the volume of the container should be allowed for this expansion.

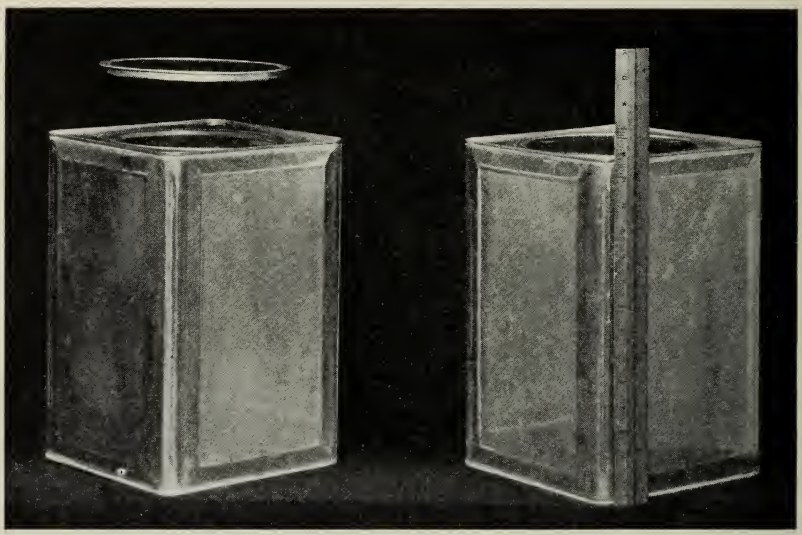


Fig. 28.—Five-gallon enameled can for cold-packing fruit juices and syrups.

In large barrels (25 or 50 gallons) cooling is very slow and during the cooling period fermentation may begin. Better results are obtained if the juice is precooled in a milk cooler to 40–32° F before filling into barrels. It cools quickly at 0–10° F in 5-gallon containers for which precooling is not needed.

Preservation by use of Preservatives.—Sodium benzoate is the only permissible food preservative that is practicable for use in preserving fruit beverages, concentrates, sweetened juices and syrups. One-tenth of one per cent is sufficient. There is a popular prejudice against sodium benzoate and on this account pasteurization should be employed whenever feasible.

Sodium benzoate varies greatly in quality. Some grades possess a medicinal "iodoform" taste and odor that renders it wholly unfit for use in fruit products.

One-tenth of one per cent corresponds to about 7 ounces of benzoate to 50 gallons of fruit juice; or to about 8 ounces to 50 gallons of 50° Balling syrup. The benzoate should be weighed and then dissolved in water before adding to the fruit juice. A solution containing one pound of benzoate dissolved in water and diluted with water to one gallon makes a solution of convenient strength. One pint of this solution contains 2 ounces of sodium benzoate. After addition to the juice or syrup the liquid must be thoroughly stirred to insure mixing.

Carbonated bottled fruit beverages keep satisfactorily with 0.05 per cent of sodium benzoate, i.e., 5/100 of 1 per cent. The amount of benzoate necessary to give this concentration in the bottled beverage is added to the syrup. Thus if 2 ounces of syrup is used to a 6-ounce bottle, then the syrup must contain 0.15, or 15/100 of 1 per cent of sodium benzoate. The presence of sodium benzoate must be printed in prominent type on the label. For further information on this very important point write the State Food and Drug Laboratory, University of California, Berkeley.

THE CONCENTRATION OF FRUIT JUICES FOR USE IN BEVERAGES[6]

Fruit juices can be concentrated for use in beverages in any one of several ways, although for general use concentration in vacuo is the most suitable. The various methods are described in detail in Bulletin 392 of this Station so will be presented here only very briefly. The following methods have been used most successfully:

Concentration in Vacuo.—Concentration at atmospheric pressure results in the loss of flavor and color and often in caramelization. These difficulties may be avoided by concentrating under vacuum. Under a vacuum, liquids boil at lower temperature than in the open and moisture is removed with less injury to the juice. "Vacuum pan" is the name applied to the commercial apparatus utilizing this principle.

Concentration by the Spray Process.—This process which is used extensively for drying milk, has been used successfully for making powdered lemon juice. Powdered orange juice was lacking in flavor. An excellent grape syrup was made by this process. The process consists in spraying the juice into a large chamber into a blast of heated air. Drying takes place almost instantaneously. It is believed that the spray process has great possibilities as a means of concentrating fruit juices but further experiments are necessary.

[6] Directions for making fruit juice concentrates have been given in: Irish, John H. Fruit juice concentrates. California Agr. Exp. Sta. Bul. 392:1–20. 1925.

TABLE 6

BALLING SACCHAROMETER READINGS FOR SUGAR SYRUPS AT VARIOUS TEMPERATURES
(After J. R. Bell, Oregon Agricultural College)

Temp. Fahr.	Degree of concentration desired									
	10	15	20	25	30	40	50	60	70	75
	Saccharometer reading at temperature observed									
32	10.41	15.52	20.62	25.72	30.82	40.98	51.11	61.22	71.25	76.29
41	10.37	15.44	20.52	25.59	30.65	40.75	50.80	60.88	70.91	75.94
50	10.29	15.33	20.36	25.39	30.42	40.49	50.50	60.54	70.58	75.61
54	10.22	15.24	20.26	25.29	30.31	40.34	50.36	60.40	70.42	75.46
57	10.16	15.17	20.18	25.19	30.21	40.22	50.23	60.26	70.28	75.32
61	10.08	15.19	20.10	25.10	30.11	40.12	50.12	60.14	70.16	75.18
62	10.03	15.03	20.03	25.04	30.04	40.04	50.04	60.05	70.05	75.06
*63**	*10.00*	*15.00*	*20.00*	*25.00*	*30.00*	*40.00*	*50.00*	*60.00*	*70.00*	*75.00*
64	9.97	14.97	19.97	24.97	29.97	39.97	49.97	59.97	69.97	74.98
68	9.92	14.91	19.91	24.90	29.90	39.90	49.90	59.90	69.92	74.94
72	9.71	14.69	19.69	24.68	29.68	39.67	49.66	59.68	69.71	74.75
75	9.59	14.57	19.56	24.54	29.54	39.53	49.50	59.54	69.57	74.60
79	9.46	14.44	19.42	24.40	29.39	39.38	49.34	59.38	69.42	74.45
82	9.32	14.30	19.28	24.24	29.24	39.22	49.18	59.22	69.28	74.39
86	9.18	14.13	19.18	24.08	29.06	39.02	49.06	59.12	69.12	74.14
90	9.02	13.91	18.97	23.92	28.92	38.90	48.86	58.90	68.97	74.02
93	8.86	13.84	18.79	23.76	28.76	38.72	48.70	58.74	68.81	73.83
97	8.68	13.67	18.62	23.59	28.59	38.54	48.53	58.58	68.65	73.67
100	8.51	13.49	18.45	23.41	28.41	38.36	48.35	58.40	68.49	73.51
104	8.33	13.29	18.27	23.21	28.21	38.18	48.17	58.22	68.31	73.35
108	8.14	13.11	18.07	23.01	28.01	38.00	47.99	58.04	68.15	73.19
110	8.04	13.01	17.97	22.91	27.91	37.90	47.90	57.95	68.07	73.11
112	7.94	12.99	17.87	22.81	27.81	37.80	47.81	57.86	67.98	73.03
115	7.73	12.70	17.66	22.61	27.61	37.60	47.61	57.68	67.80	72.77
117	7.62	12.59	17.55	22.51	27.51	37.50	47.51	57.59	67.71	72.76
119	7.51	12.48	17.46	22.41	27.41	37.40	47.41	57.50	67.62	72.75
121	7.40	12.37	17.33	22.31	27.31	37.30	47.31	57.40	67.53	72.58
122	7.29	12.26	17.22	22.20	27.20	37.20	47.21	57.30	67.44	72.49
124	7.19	12.16	17.11	22.10	27.10	37.09	47.11	57.20	67.35	72.40
126	7.08	12.06	17.00	21.99	26.99	36.98	47.01	57.10	67.26	72.31
128	6.97	11.96	16.89	21.88	26.88	36.87	46.91	57.00	67.17	72.22
130	6.86	11.85	16.78	21.77	26.77	36.76	46.81	56.90	67.08	72.13
131	6.74	11.74	16.67	21.67	26.67	36.71	46.70	56.80	67.00	72.04
133	6.61	11.61	16.56	21.56	26.56	36.54	46.61	56.70	66.91	71.95
135	6.48	11.48	16.45	21.45	26.45	36.43	46.57	56.60	66.82	71.86
137	6.36	11.36	16.34	21.34	26.34	36.22	46.40	56.56	66.73	71.77
139	6.24	11.24	16.23	21.23	26.23	36.21	46.29	56.40	66.65	71.68
140	6.18	11.12	16.12	21.12	26.12	36.10	46.18	56.30	66.57	71.59
149	5.47	10.46	15.49	20.49	25.51	35.52	45.64	55.79	66.05	71.12
158	4.82	9.80	14.86	19.87	24.90	34.94	45.10	55.68	65.73	70.65
167	4.00	9.10	14.16	19.21	24.26	34.34	44.57	54.73	65.01	70.16
176	3.38	8.61	13.46	18.54	23.62	33.74	43.94	53.61	64.50	69.67
185	2.56	7.62	12.70	17.79	22.90	33.08	43.32	53.18	63.96	69.15
194	1.74	6.84	11.94	17.03	22.15	32.42	42.70	53.04	63.42	68.63
203	0.86	5.98	12.11	16.23	21.39	31.65	42.03	52.41	62.83	68.10
212	0.01	5.13	10.28	15.46	20.61	30.97	41.36	51.78	62.24	67.58

* The Balling saccharometer is calibrated at about 63 degrees Fahrenheit. Therefore the figures in the columns opposite that temperature appear as whole numbers and are identical with the degree of concentration sought in the syrup as indicated at the head of the respective columns. The corrected saccharometer reading will be higher or lower as the temperature varies from 63 degrees.

Concentration by Freezing.—This process is the best for preserving the aroma and color of the original fruit. It consists of freezing the fruit juice and then separating the ice crystals from the concentrated juice. Those wishing to use these processes in the preparation of fruit juices can obtain detailed information from the manufacturers of the equipment. Sometimes equipment can be adapted to purposes other than those for which it was intended.

TEMPERATURE CORRECTION FOR SYRUP TESTS

The temperature at which fruit juices and syrups are made for preparation of beverages varies. Since temperature markedly affects the indicated reading of hydrometers, for accuracy and uniformity in the preparation of beverages it is necessary to make corrections for these variations in temperature. The accompanying temperature correction table for sugar syrups provides a quick and fairly accurate means for making this correction. An example will illustrate the use of the table (table 6). Suppose the bottler desires a concentration in the syrup of 50° Balling and that the temperature is 140° F. In the vertical column under 50° Balling opposite the temperature 140° F is found the figure 46.18. His 50° Balling syrup will test 46.18° Balling at 140° F, i.e., he should make a syrup testing 46.18° Balling (about 46.2° Bal.). If he desires a syrup which will test 50° Balling at a room temperature of 63° F there is no correction.

BOTTLING AND SEALING CARBONATED BEVERAGES

Seven and eight ounce bottles are the common sizes for bottling. Most syrups are used at the rate of one and one-half fluid ounces (about 45 cubic centimeters) to a bottle, the bottling machine being adjusted to deliver this amount of syrup to each bottle. Carbonated water is then added to fill the bottle within about one and one-fourth inches of the top and the bottle is immediately sealed with a crown cap. Sixteen and thirty-two ounce bottles may be used for carbonated fruit beverages when the low pressure carbonating system is used.

ESTIMATED COST OF PRODUCTION

The cost of producing various carbonated fruit beverages, in the Fruit Products Laboratory is summarized in tables 7 and 8. The fruit was purchased in many cases in the wholesale fruit markets. Grapes were obtained from the Viticulture Division at the University Farm, Davis, at prices prevailing at the time of harvest.

TABLE 7

ESTIMATED COST OF FRUIT SYRUPS

Fruit	Cost of fruit per ton	Syrup, cost of one gallon				Total per gallon
		Fruit	Sugar	Power and labor	Pasteurizing, and container	
	dollars	*dollars*	*dollars*	*dollars*	*dollars*	*dollars*
Apple	15.00	0.50	0	0.25	0.20	1.00
Blackberry	143.00	0.56	0.34	0.15	0.20	1.25
Red grape	50.00	0.90	0	0.25	0.20	1.35
Muscat grape	50.00	0.63	0	0.25	0.20	1.08
Lemon	20.00	0.40	0.36	0.15	0.20	0.81
Loganberry	143.00	0.70	0.30	0.15	0.20	1.35
Orange*	20.00	0.20	0.36	0.15	0.20	0.91
Orange (concentrate)†	20.00	1.20	0.12	1.00	0.20	2.52
Pomegranate	20.00	0.14	0.12	0.20	0.20	0.66
Raspberry	333.00	1.26	0.34	0.15	0.20	1.95
Strawberry	205.00.	0.84	0.36	0.15	0.20	1.55

* Made with added sugar and not vacuum concentrated.

† Vacuum concentrated 3½ to 1.

TABLE 8

ESTIMATED COST OF FRUIT BEVERAGES

Kind	Beverage cost of one 8-ounce bottle in cents						Total exclusive of bottle
	Syrup	Labor	Bottle*	Pasteurizing	Label	Total, with bottle	
	cents	*cents*	*cents*	*cents*	*cents*	*cents*	*cents*
Apple	1.25	.46	2.5	.5	.1	4.81	2.31
Blackberry	1.56	.46	2.5	.5	.1	5.12	2.62
Red grape	1.69	.46	2.5	.5	.1	5.25	2.75
Muscat grape	1.35	46	2.5	.5	.1	4.91	2.41
Lemon	1.01	.46	2.5	.5	.1	4.57	2.07
Loganberry	1.69	.46	2.5	.5	.1	5.25	2.75
Orange	1.01	.46	2.5	.5	.1	4.57	2.07
Pomegranate	.83	.46	2.5	.5	.1	4.39	2.89
Raspberry	2.44	.46	2.5	.5	.1	6.00	3.50
Strawberry	1.94	.46	2.5	.5	.1	5.40	2.90

* In this estimate reclaimed bottles were used which accounts for the low cost of this item. New bottles cost 3½ to 4 cents each.

Bottlers usually make a charge to the customer for bottles and cases. In some instances this is $1.50 per case of two dozen bottles, or at the rate of approximately 6 cents a bottle. This charge is refunded on return of the cases and bottles. In table 8 the last column represents the net cost to the bottler who prepares his own syrups. These figures are, of course, only approximate; great accuracy is not claimed.

BUILDINGS AND EQUIPMENT FOR FRUIT BEVERAGE PRODUCTION

Figure 29 shows the arrangement of equipment for convenient and economical operation of a juice plant based on the commercial production of apple cider pasteurized in bottles, ready to go to the bottler for carbonating, or to be used without further preparation, as a beverage.

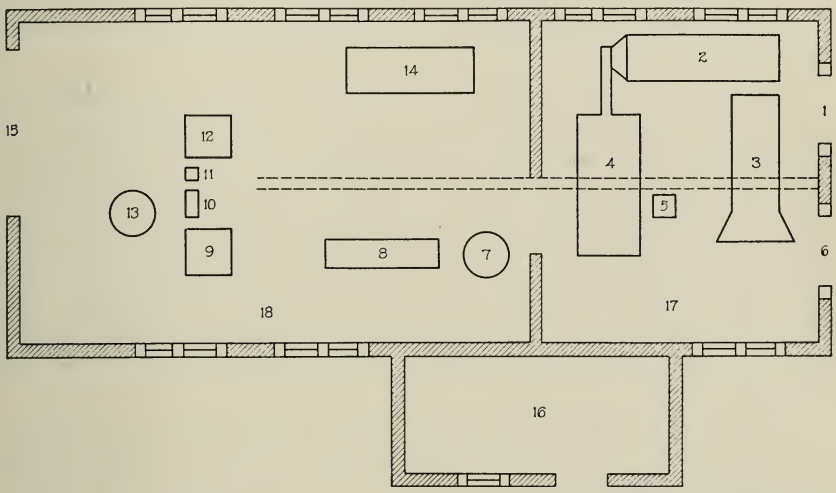


Fig. 29.—Typtical plant layout for making fruit juices and fruit beverages (carbonating equipment omitted).

1. Fruit receiving door.
2. Washer.
3. Sorter.
4. Crusher and press.
5. Juice pump.
6. Pomace removal door.
7. Mixing tank.
8. Filter press.
9. Empty bottle rack.
10. Bottle filler.
11. Bottle capper.
12. Filled bottle rack.
13. Bottling tank.
14. Pasteurizer.
15. Finished product handled through doorway.
16. Boiler room.
17. Press room.
18. Refining room (filtering, bottling, etc.).

The floor plan for installing the various pieces of equipment will vary according to the size of factory, kind of fruit used, space available and many other conditions. The layout illustrated in figure 29, therefore, is very general in character and subject to modification to suit local conditions. It has, however, been so prepared as to permit efficient handling of the fruit and the products made from it.

DEFINITION OF TERMS

The Bureau of Chemistry of the United States Department of Agriculture, Food, Drugs and Insecticide Administration, for convenience in inspection, has defined various products. It is important

that the manufacturer of such products be familiar with these definitions. Since regulations are modified from time to time it is necessary to keep in touch with the administration to be able to comply with the law.

The State food inspection law of California is practically the same as the Federal law so there need be no confusion in this respect.

The laws of different states vary, so it is necessary to become familiar with them if products are to be sold outside of California.

Following are definitions of fruit products used in the beverage industry.

Sweetened juice is the name applied to fruit juice to which has been added less than 50 per cent of cane sugar. This is the form in which tart or sour juices such as grapefruit, lemon, lime, orange, pineapple, pomegranate and the juices of various kinds of berries are best for use in preparing both still and carbonated beverages. When diluted by adding four or five parts of water to one part of sweetened juice the characteristic fruit flavor is retained and the beverage is not too sweet. Still drinks made from sweetened juice are properly called fruit "ades." Lemonade and orangeade are familiar examples.

Fruit syrup is the name applied to fruit juices to which have been added 50 per cent or more of cane sugar and must contain at least 33⅓ per cent of pure fruit juice.

With most fruit syrups when diluted to beverage strength the proportion of fruit juice is low and consequently the fruit flavor is weak. When diluted to drinking strength the ratio of sugar to juice is too high and the taste is too sweet. Fruit syrups can best be used in soda fountain specialties such as sundaes, in fruit malts, ice cream sodas or for blending in making fruit punches. If they are used in bottled carbonated beverages it is usually necessary to add fruit acid to counterbalance the excessive sweetness.

Fruit juice concentrate is the name applied to fruit juices which have been concentrated by evaporation of the excess water under vacuum or at atmospheric pressure or by freezing and subsequent separation of the ice and concentrated juice. Citrus juice concentrates suitable for use in beverages are now available. Several citrus concentrate factories are in successful operation in California. Grape concentrates of good quality are obtainable from several California factories. Most of the apple concentrates on the market are made by evaporating in the open at atmospheric pressure and they consequently possess a cooked taste. Pineapple concentrate is produced

in limited quantities. In the Fruit Products Laboratory it has been demonstrated that concentrates thoroughly satisfactory for use in beverages can be prepared from most of the important fruits grown in California.

APPLE JUICE OR CIDER

Apple juice or cider is probably the most popular fruit juice consumed in the United States. It contains the proper proportion of sugar, requires no sweetening or dilution and is low in price. For these reasons there is little need to convert it into "appleade" or soda water, etc.

"Appleale" is a beverage made by flavoring apple juice with ginger extract or mixing it with ginger ale extract. Since the strength of ginger extract is so variable it is impossible to give directions for the proportions of cider and extract required for the blend. Better results are obtained by mixing equal parts of apple juice and ginger ale of good quality. Served cold this mixed drink is very pleasing and refreshing. Several imitation "appleades" and synthetic apple syrups are on the market but have made little headway against the real juice.

CITRUS FRUIT JUICE BEVERAGES

The only very successful citrus fruit juice beverages have been those made from the fresh fruit for immediate consumption. Through the efforts of the California Fruit Growers Exchange, orange juice extracting machines have been installed in most soda fountains and thousands of carloads of cull oranges are used for preparing fountain drinks.

Several imitation citrus juice beverages, because of extensive advertising are consumed in large quantities.

Attempts to prepare bottled beverages to be stored several months for future consumption have resulted in failure. Many promoters and investors have lost large sums of money in attempts to prepare and market such beverages. The cause of failure is that discussed elsewhere, namely, that bottled citrus juices soon deteriorate in flavor when stored at room temperature.

An ideal citrus beverage is one that possesses all of the flavor and aroma of the freshly expressed juice. Methods of preparation should be such as to alter this original fresh fruit flavor and aroma as little as possible. In most commercial attempts to prepare such beverages in recent years the lowest possible temperatures that would destroy the spoilage organisms have been employed. However, the

most serious type of spoilage in citrus juices is not that caused by microörganisms but chemical and enzymatic action. The development of a characteristic "stale taste" is caused by a chemical change apparently in part at least induced by enzymes. Enzymes are substances that have the power of inducing certain chemical changes.

The enzymes are not destroyed by the ordinary pasteurization temperatures commonly used to kill yeasts and molds, but they are destroyed at a temperature of from 190° to 200° F according to experiments. Heating citrus juices to such a high temperature in open vats causes a deterioration which is objectionable. This difficulty can be overcome by "flash heating," that is, by bringing it to 200° F by passing the juice through a coil heated by boiling water and then passing through a cooler to reduce the temperature of the juice immediately. In tests juice treated in this way was held at room temperature ten days without any noticeable deterioration. Tests have proved that by the addition of 1/10 of 1 per cent sodium benzoate to this juice it can be stored in clean paraffined barrels in cold storage at about 32° F for several months without appreciable change in flavor and color. It may be stored at 0°–15° F without use of benzoate. Either procedure would permit bottlers to store a supply of juice.

Sweetened orange juice is prepared from this treated juice in the following manner: To 100 gallons of mixed citrus juices consisting of 75 gallons of orange juice and 25 gallons of lemon juice is added 700 pounds of sugar and emulsified orange oil to flavor.

If to be stored at room temperature the amount of sodium benzoate must be increased to 1/10 of 1 per cent. The foregoing quantity yields about 155 gallons of "sweetened juice" about 49° Balling.

A *still orange beverage* is prepared from the sweetened juice by adding one part of sweetened juice to four parts of distilled water.

A *carbonated orange beverage* is prepared by adding 1½ ounces of the sweetened juice to a 6-ounce bottle or 3 ounces to a 12-ounce ginger ale bottle. Carbonated distilled water at 30 pounds pressure (about 2 volumes of gas) at 40° F is added to fill the bottles.

Pasteurization is required for all of the bottled fruit beverages unless sufficient benzoate of soda is added to give 1/10 of 1 per cent in the finished drink. Still beverages must be pasteurized at 175° F for 30 minutes. Carbonated beverages must be pasteurized at 150° F for 30 minutes.

Sweetened lemon juice is prepared in a manner similar to that described for sweetened orange juice. To 100 gallons of lemon juice extracted by burring is added 700 pounds of cane sugar and 1/10

of 1 per cent of sodium benzoate. To this is added emulsified lemon oil to taste. This will yield about 155 gallons of sweetened juice of about 49° Balling.

A *still lemon beverage* is prepared by adding one part of sweetened juice to seven or eight parts of distilled water.

A *carbonated lemon beverage* is prepared by adding 1½ ounces of the sweetened juice to a 6-ounce bottle, or 3 ounces to a 12-ounce bottle and carbonating at 30 pounds pressure (about 2 volumes of gas) at 40° F, using distilled water.

Sweetened grapefruit juice is prepared by adding to 100 gallons of burred juice 700 pounds of cane sugar and 1/10 of 1 per cent sodium benzoate. This will yield about 155 gallons of sweetened juice of about 49° Balling.

A *still grapefruit beverage* is prepared by adding one part of sweetened juice to four or five parts of distilled water.

A *carbonated grapefruit beverage* is prepared by adding 1½ ounces of sweetened juice to a 6-ounce bottle or 3 ounces to a 12-ounce bottle and carbonating under 30 pounds pressure (about 2 volumes of gas) at 40° F, using distilled water.

Tangerine and *lime* beverages can be prepared in the same manner as those from grapefruit.

Fruit punches can be made by various combinations of citrus and other sweetened juices. One of the most pleasing combinations consists of equal parts of sweetened orange, lemon and grapefruit juices with enough sweetened pomegranate juice, blackberry juice, red grape juice to produce the desired color. To this mixture may be added crushed pineapple, shredded orange, bananas, maraschino cherries, berries or other fruits to improve the appearance in the punch bowl.

Orange concentrate has proved the most popular of the citrus concentrates for use in beverages. In fact, it is the most extensively used of all fruit juice concentrates for this purpose.

Beverages made from orange concentrate are preserved by pasteurization at 150° F for 30 minutes or by the addition of 1/10 of 1 per cent benzoate of soda.

An orange syrup suitable for use by bottlers has been prepared commercially as follows:

1 gallon 72° Balling orange concentrate.
5 gallons of 60° Balling simple syrup (cane sugar and water).
¼ fluid ounce of terpeneless orange oil (emulsified).

1½ ounces of this syrup is added to a 6½-ounce bottle and carbonated water added to fill.

There are two types of carbonated citrus fruit beverage:

(1) The ginger ale type, possessing high carbonation. Water for use in this beverage is carbonated under 30 pounds pressure (about 2 volumes of gas) at 40° F. This beverage is especially suitable for mixing with other drinks.

(2) The low pressure type, for which the water is carbonated under 15 to 30 pounds pressure (1 to 2 volumes of gas) at 50°–60° F. This beverage is better than (1) for drinking unmixed with other beverages.

Lemon concentrate because of its high acidity and distinctive flavor is one of the most satisfactory fruit concentrates. The following formula has been found satisfactory for using lemon concentrate:

1 gallon 72° Balling freshly prepared commercial lemon concentrate.
20 gallons 60° Balling simple syrup.
⅔ fluid ounce of terpeneless lemon oil (emulsified).

Lemon beverage is made by adding: ½ ounce of this syrup to each 6½-ounce bottle and carbonated water added to fill. Either the high or low carbonation may be used as with orange beverages. The beverage is preserved either by pasteurization or by sodium benzoate.

Where sufficient quantities of grapefruit, limes, tangerines and other citrus fruits are available, their juices can be concentrated and used in a manner similar to that described for orange and lemon concentrates.

GRAPE JUICE BEVERAGES

Grapes best suited for beverages are described elsewhere in this circular, in the paragraph headed "Varieties of Grapes for Juice."

Sweetened grape juice can be prepared by adding cane sugar to Concord or Isabella or to mixed Muscat and red grape juice to bring the juice to 45°–50° Balling. To one part of sweetened juice is added three parts of still or carbonated water if the juice is to be served as a fountain drink. If the juice is to be made into a bottled beverage about 2 fluid ounces is used to a 6-ounce bottle or 2¾ ounces to an 8-ounce bottle; and water carbonated to about 60 pounds pressure (4 volumes of gas) at 40° F is added. For low carbonation about 30 pounds pressure (about 2 volumes of gas) at 50°–60° F is used.

Equal parts Muscat and red grape juice has been found to be the best proportions of the two juices for most beverage purposes. The red juice should be high in acid, that is, very tart. This condition is attained if slightly unripe grapes or a considerable proportion

of second crop grapes are used. If thoroughly ripe Muscat grapes are used the blended juices need not be sweetened. If sugar is not added the dilution with carbonated water should be in the ratio of about one part of water to one of the unsweetened juice.

Very satisfactory *grape concentrates* are now available in commercial quantities at moderate prices. These are prepared in most factories by concentration in vacuo. The usual density is about 70° Balling which represents a concentration of about 3½:1. The Muscat juice should be concentrated by the freezing process instead of by evaporation in order that the volatile flavor may be retained. If the Muscat juice is concentrated by freezing a concentrate of about 50°–55° Balling only is obtained; sugar may be added to increase the density to 70° Balling.

In using the concentrates, 1 part of Muscat to 2 parts red juice concentrate will be satisfactory. The mixture is diluted to beverage strength with 4 to 5 volumes of water (still or carbonated according to the product desired). As the concentrates are usually deficient in acid owing to separation of cream of tartar, it is usually necessary to add a small amount of citric or tartaric acid to the beverage.

A carbonated, bottled, blended Muscat-Petite Sirah beverage was produced and sold by the Fruit Products Laboratory for about a year and proved second in popularity only to orange beverage. It is believed that this beverage which was called Muscat Blend has great commercial possibilities.

Preservation of Bottled Grape Beverages.—Bottled grape beverages require pasteurization or addition of sodium benzoate as described for citrus juices.

BEVERAGES FROM OTHER FRESH FRUITS

The juices of *strawberries, loganberries, raspberries* and *blackberries* are suitable for beverage purposes. They have sufficiently high acidity, low sugar content and strong flavor to permit the addition of sugar and dilution with water and still make palatable beverages. Sweetened juice 45°–49° Balling is the form in which these juices are best suited to the preparation of beverages. The addition of 1 part of sweetened juice to 4 or 5 water gives a beverage which is satisfactory to most consumers. The juice is easily extracted by crushing the berries, heating to 150°–160° F, and pressing.

The beverages can be prepared in the form of "ades" by the addition of still water or they can be carbonated either under low pressure or high pressure according to requirements.

The carbonated drinks may be bottled and pasteurized or may be served as fountain drinks.

Raspberry juice beverage possesses a very pleasing flavor but the high cost of the fruit and its scarcity renders its use impracticable in California.

Loganberry juice is available in quantity at moderate prices, particularly from the Pacific Northwest. The high flavor and acidity permit sweetening and dilution. Owing to the loss of color and flavor in unsweetened juice it is recommended that loganberry juice be sweetened to 45°–50° Balling at the factory. The sweetened juice retains the fresh flavor and color very satisfactorily. Pasteurization at 175° F is a satisfactory method of preservation.

Strawberry juice has a strong characteristic flavor but has a very unstable color. After standing a few weeks exposed to light or at room temperature the red color fades or changes to an objectionable brownish color. If, however, the juice is sweetened to 45°–50° Balling and stored at 0–10° F it retains its fresh color indefinitely. For a bottled beverage the strawberry juice should be mixed with blackberry juice. The latter furnishes color without greatly changing the strawberry flavor. One part of sweetened blackberry to 3 parts sweetened strawberry make a satisfactory mixture. The mixture may be labeled "strawberry-blackberry" blend.

Blackberry juice does not have a very distinctive flavor and therefore it has not been so popular as the other berry juices. It has, however, a deep purplish red color which is fairly permanent and makes the juice valuable for blending with strawberry juice which is lacking in color. See preceding paragraph.

Black cherry juice has possibilities for use in beverages as its characteristic color and flavor are not easily destroyed by heat and light. The deficiency in acidity can be supplied by adding citric acid. To prepare the sweetened juice crush the whole cherries and a few of the pits. Heat to 160°–170° F for 15 minutes. Press and filter. Add sugar to increase juice to 45°–50° Balling and about 1 ounce of citric acid to the gallon. Use as previously directed for other sweetened juices

Pomegranate juice beverage is popular with those who are familiar with the fruit and have learned to like it. Owing to the fact that in bottled form the beverage deteriorates in flavor and color it is recommended as a fountain drink. The juice is extracted by pressing the whole uncrushed fruit as described under "Pomegranate juice." The resulting juice is made to 35° Balling by addition of sugar and is preserved by pasteurization. Beverage is prepared by using equal

parts of sweetened juice and water, either still or carbonated, although it is generally preferred as a still drink. The beverage is much improved by the addition of grapefruit juice or orange juice to furnish flavor.

BEVERAGES FROM DRIED FRUITS

Beverages can be prepared from sun dried or dehydrated raspberries, loganberries, blackberries and red wine grapes as follows: Soak over night in enough water to return to the fruits the water removed in drying. After thus "refreshing" the dried fruits the procedure is the same as for fresh fruits.

While beverages of fair quality can be prepared from these dried fruits they are less palatable, less attractive in color and decidedly inferior in flavor to those made from the fresh fruits.

Raisin beverage[7] it is believed has commercial possibilities. It has been prepared in our investigations as follows: Mix about 50 pounds each of Thompson seedless and Muscat raisins, lightly crushed, in Muscat raisin seeder rolls or similar device. Add 30 gallons of water. Heat to 175° F for 10 minutes. Allow to stand over night. Draw off the liquid and press the raisins. Place the liquid thus obtained on a second lot of raisins equal in weight to about one-half of the weight of the juice and repeat the extraction process as previously described. Continue the extraction process by adding to the first lot of raisins extracted a second lot of fresh water. Use this extract to treat fresh raisins. From this point in the continuous operation of the process each lot of raisins is extracted three times, i.e., once fresh with juice which has been in contact with two lots of partially extracted raisins, once with juice that has been in contact with one lot of extracted raisins and finally once with fresh water. In this manner most of the sugar is recovered. The extract should test about 50°–55° Balling.

A raisin concentrate has been prepared by decolorizing the extract with vegetable charcoal as described below and concentrating in vacuo to 65° Balling. The concentrate is preserved by pasteurization at 175° F for 30 minutes. It is usually necessary to partially decolorize the extract in order that the beverage will not be cloudy. This is accomplished by heating the juice to 175° F for 30 minutes with from ½ to 1 per cent by weight of any one of several good powdered vegetable decolorizing carbons and filtered by adding ½ of 1 per cent by weight of diatomaceous earth and passing through a plate and frame filter.

[7] The experiments with raisin beverages were conducted by W. V. Cruess and J. G. Brown.

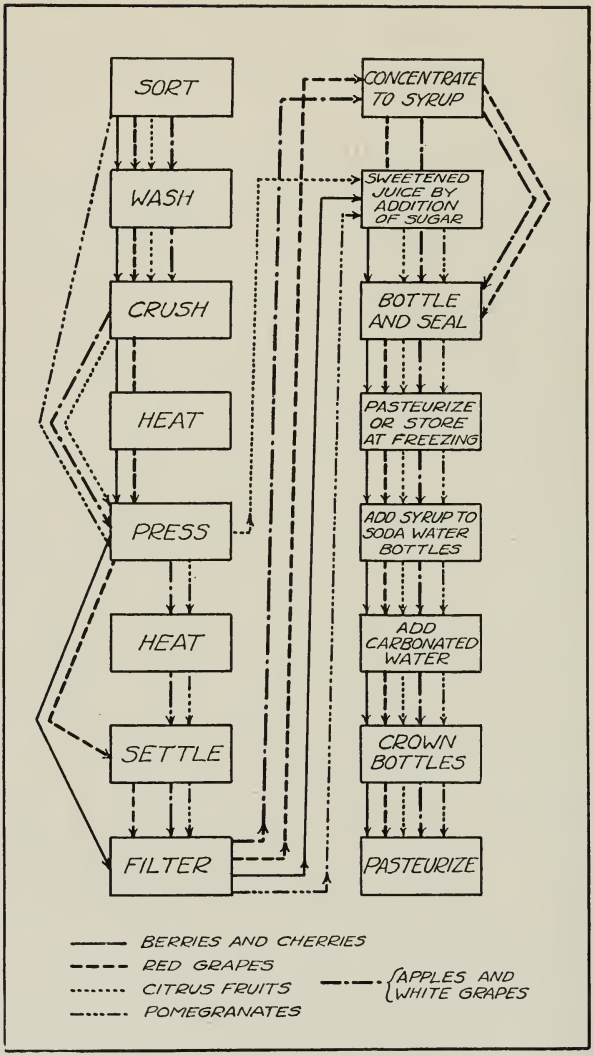


Fig. 30.—Outline of processes of preparing beverages from various fruits.

"*Raisin ale*" is a carbonated beverage made from the raisin extract by flavoring the raisin extract with ginger ale extract of high quality. The mixed liquid is used as follows: 1½ ounces is added to a 6½ ounce bottle and carbonated under 30 pounds pressure (about 2 volumes of gas) at 40° F. This produces a highly carbonated beverage similar to ginger ale. The Muscat raisin flavor is discernable.

Fig beverage can be made by the extraction method described for raisin beverage. The fig beverage lacks flavor, but if mixed with orange or other highly flavored juice it may have possibilities as a health beverage.

Dried prunes have been used for preparation of a beverage by the process described for raisins but the beverage lacks flavor. When mixed with orange juice it is improved. Owing to the healthfulness of prune products such a mixed beverage probably has commercial possibilities. Further investigations are in progress in the Fruit Products Laboratory on prune syrups, prune extracts and beverages.

SUMMARY OF PROCESSES OF MAKING CARBONATED FRUIT BEVERAGES

The processes of preparing syrups, sweetened juices, concentrates and carbonated beverages from the different fruits naturally vary considerably in respect to various important details. However, it is possible to prepare a condensed set of general directions which will give a "bird's-eye view" of the steps recommended for the preparation of the more important bottled carbonated beverages. This has been done in the accompanying diagram, figure 30.

FIRMS SUPPLYING FRUIT JUICE AND BEVERAGE EQUIPMENT

For the convenience of those interested in the preparation of fruit juices or beverages from fruit juices the following list of firms is given:

General Equipment—

Anderson-Barngrover Mfg. Co., 20 Fremont Street, San Francisco, Calif.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.

Crushers and Presses—

California Press Mfg. Co., 1800 Folsom Street, San Francisco, Calif.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Enterprise Mfg. Co., Philadelphia, Pa.

Filters—

Cellulo Filter Co., Sandusky, Ohio.
John Mulhern Co., 182 Second Street, San Francisco, Calif.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Karl Kiefer Mfg. Co., Cincinnati, Ohio.
Philipp Wirth, 332 Spring Street, New York City, N. Y.
D. R. Sperry & Co., Merchants Exchange Bldg., San Francisco, Calif.

Glass-enameled Equipment—

Pfaudler Co., Rochester, N. Y., and 57 New Montgomery Street, San Francisco, Calif.
The Glasscote Company, Euclid (Cleveland), Ohio.

Glass Manufacturers—
Illinois-Pacific Glass Co., San Francisco, Calif.
Pacific Coast Glass Co., San Francisco, Calif.
Owens Glass Co., Sheldon Bldg., San Francisco, Calif.
McLaughlin Glass Co., Los Angeles, Calif.
Southern Glass Co., Los Angeles, Calif.
Filtering Materials—
Celite Products Co., San Francisco, Calif.
Pasteurizers—
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Modern Machinery Co., Wilmington, Del.
Vacuum Pans—
Concentrators Co., 216 Pine Street, San Francisco, Calif.
Pfaudler Co., Rochester, N. Y.
Oakland Copper and Brass Works, 1346 Seventh Street, Oakland, Calif.
The Glasscote Co., Euclid (Cleveland), Ohio.
Soda Fountain and Bottlers' Supplies—
Eng-Skell Co., 208 Mission Street, San Francisco, Calif.
Magnus Fruit Products Co., 301 Howard Street, San Francisco, Calif.
Sierra Club Beverage Co., Inc., Glendale, Calif.
John Mulhern Co., 182 Second Street, San Francisco, Calif.
Trade Journals—
Pacific Bottler, 57 Post Street, San Francisco, Calif.
The Beverage Journal, 431 South Dearborn Street, Chicago, Ill.
The Beverage News, 21 Spruce Street, New York City, N. Y.
The Fruit Products Journal and American Vinegar Industry, 31 Union Square, New York City, N. Y.

COMPANIES DEALING IN FRUIT JUICES AND FRUIT JUICE CONCENTRATES

Apple Juice—
Adelanto Fruit Products Co., 4094 Mission Road, Los Angeles, Calif.
Macomber Orchard Co., Sonora, Calif.
Martinnelli, Watsonville, Calif.
Citrus Juices and Concentrates—
The Exchange Orange Products Co., Ontario, Calif.
The Exchange Lemon Products Co., Corona, Calif.
California Crushed Fruit Corporation, 1600 E. Sixteenth Street, Los Angeles, Calif.
Oscar Bulger Co., San Diego, Calif.
Grape Juices and Concentrates—
The California Grape Products Co., Ukiah, Calif.
Italian Vineyard Co., Los Angeles, Calif.
Guasti Grape Products Co., Los Angeles, Calif.
Italian Swiss Colony, Asti, Calif.
A. Joseph Co., Fresno, Calif.
National Fruit Products Co., Lodi, Calif.
Golden Gate Grape Juice Co., San Francisco, Calif.